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NOTES.

Indian Telegraphs.—Mr. J. J. Allen, Indian Government electrician, is returning to England on short leave.

Spanish Telegraphs.—Don Rafael Monares has been appointed director-general of posts and telegraphs in Spain.

Index.—We have received the "Index" to the *Journal* of the Institution of Electrical Engineers, 179 pages, from Messrs. Spon and Co.

Channel Lighthouses.—A new lighthouse is to be erected in the Bristol Channel, at the east bank of the River Usk, by June next.

Malta.—Mr. W. H. Preece is on a visit to Malta to confer further with the local Government on the proposed installation of the electric light.

Telautograph.—Prof. Elisha Gray has perfected his writing telegraph, and the manufacture at a small town, Highland Park, has begun on a large scale.

Simple Induction Coil.—The simplest possible induction coil is one recently patented by Dr. Silvanus Thompson, composed of coils of iron wire, the turns being simply insulated by a coating of oxide.

Society of Arts.—The first Howard lecture by Prof. W. Cawthorne Unwin, F.R.S., on "The Development and Transmission of Power from Central Stations," will be given before the Society of Arts on Friday, January 13, at 8 p.m.

Long-Distance Telephones.— During the severe storm of a fortnight ago the New York telegraph system broke down for two hours, while the long-distance telephone lines remained intact, and business was carried on through them.

Paddington Railway.—In the *Times* of yesterday are two letters—from H. Seton Karr and "Londoner"—for and against the proposed project of the Clapham and Paddington subway railway, with reference to its effect on the Kensington Gardens.

Electric Belts.— Manufacturers of electric belts, magnetic shoes, and so forth, will not be allowed to exhibit at Chicago, the chief electrical engineer, Mr. Barrett, having decided that "these impostors do not come within the scope of any legitimate application of electricity."

Charges.—Intending visitors to America this year will be glad to learn that there is no good ground to believe that the charges for living will be exorbitant. Hundreds of new structures are being put up, and by the time of the exhibition there will be accommodation for over 300,000 strangers, so that natural competition may be effected to keep the charges moderate.

The New Mesmerism.—A curious article of over two columns is given in the *Times* of January 5th on "The New Mesmerism" as practised in Paris, giving the theory of Dr. Luys, who believes *in the true magnetic* theory of hypnotic suggestion. This line of research has been pushed farther by Prof. Houston, who suggests the train of action gives out waves kindred to those of magnetism.

Institution.—The first of the Institution meetings during the remainder of the session will be held on Thursday, the 12th inst., when the discussion of Dr. Fleming's paper on "Alternate-Current Transformers," will be resumed. Owing to the unavoidable absence abroad of the new president, Mr. W. H. Preece, F.R.S., on this date, he will deliver his inaugural address on the 26th inst.

Prizes.—The French Académie des Sciences has awarded the Monthyon prize to M. Raffard, consulting engineer to Messrs. Breguet, for his differential dynamometer. M. Moreaux has obtained the Gay prize for his study on terrestrial magnetism, and especially that of France. The Academy will also award the Gaston Planté prze of 3,000f. This prize is to go to the French author of an electrical discovery.

Military Telephony.—Successful experiments have been made in France relative to the introduction of telephones for use in warfare. The telephonists are organised in sets of two men, each set being provided with equipment for a mile line. The very simple receiving and transmitting apparatus are attached to the military cap, and the wire is on reels in a sort of breastplate, the whole being so light that a man's ordinary equipment weighs less than 6lb.

Electric Mails.—The Post Office Department of the United States is considering a novel plan for quick distribution of mail matter at the World's Fair, submitted by the Rapid Transit Company, of Chicago. Cables on poles high enough to clear the buildings would be used, and the small mail-carts propelled by electricity at high speeds between fixed points, and so arranged as to drop mailbags and pick up others sent up by an elevator. The plan is illustrative of proposed suburban electric mails.

Photographic Lamps. — Photographers are now beginning to realise that the dark-room lantern should become a relic of the past, and a number of the more progressive members of the fraternity, says the *Optician*, are installing storage battery plants to work a ruby-coloured incandescent lamp. They say that this improvement has had a marked effect upon the health of dark-room operators, and is considered a boon to those whose time is spent continually in that unwholesome atmosphere.

Cholera.—The scare of last year has seriously frightened the authorities of Paris, Havre, and Marseilles. Precautions put on one side for lack of money now find plenty of support, and the French Government chemists have been busy in testing various microbe-killers, among which the electrified sea-water has found much favour. M. Hermite is busy installing apparatus ready for the next season's expected outbreak. We shall probably later have more to say about this interesting application of sanitary electrical engineering.

Electric Submarine Boat.—An unsuccessful trial was made the other day at Cività Vecchia of a new electric submarine boat, named "L'Audace." The boat was driven by motors supplied from accumulators, and was tested outside the harbour. The boat took half-an-hour to sink below the surface, and then suddenly sank to 15 metres. The depth of water was some 40 metres, to which depth the boat was supposed to be able to sink and rise again. The boat refused to be controlled, and had to be hauled up to the surface, and towed back to harbour by a steam launch.

Pasquet Telephones.—A simple, efficient, and inexpensive telephone set, embodying many good qualities, has been brought out in Paris by M. Pasquet, of Avenue Parmentier, under the name of the "Simplex." The transmitter is of very convenient form for fixing flat against the wall or standing on a desk; the fittings of nickel bronze are all made to standard and of great simplicity. A special set made for household and small exchanges is simple in arrangement, and as the price is very moderate and the enunciation very clear it is likely to be largely used for private telephone lines.

Lord Rowton's Lodging-House. — The palatial common lodging-house erected by Lord Rowton near Vauxhall Station is provided with hot and cold water, lockers, baths and barbers' shops, smoking and dining-rooms, and library, besides small separate sleeping-rooms or cubicles. Everything is clean and solid, and electric light smiles upon the outcome of the new 5 per cent. philanthropy. The charge for all this luxury, with a comfortable bed with hair mattresses, clean sheets and quilts, is 6d. a night. The enterprise is meant to pay, and it is to be hoped, for the sake of similar enterprises for other districts, that it will.

Non-Polarised Ammeters.—Mr. Clarence Gifford, in the *Electrical World*, gives a graphic account of the accidents that may occur with two or more shunt or compound machines working in parallel if the ammeters are non-polarised. By carelessness at light load one of the dynamos may (its current for some reason dropping to nil) commence running as a motor. If the ammeters are non-polarised the needle will still indicate the same way, the attendant regulate in the wrong direction, and the motor run away with the engine. Moral: When using non-polarised ammeters under such conditions, place a small compass below as indicator.

Invention of the Trolley System. — It has been generally taken for granted that the use of the trolley system for electric railways is free to all. This is disputed, it seems, and a suit has been begun in America by the Bidwell Electric Railway system against an electric railway in Toledo as a test case, and if they are successful every electric railway in the States would be made an infringer. The claims are made of a prior invention of the trolley system, patents being issued to Bidwell as far back as 1855, and re-issued in 1887. Cars using the system were shown in the Centennial Exhibition of 1884. The electric heating of cars is also part of the claim.

Telegrams from Railway Stations.—At the last meeting of the council of the Middlesbrough Chamber of Commerce, Mr. Walter Johnson (president) in the chair, communications were read from the Associated Chambers with respect to telegraphing from railway stations, transmission of telegrams by telephone, direct telegraphic communication throughout the empire. The General Post Office reported that they were constantly endeavouring to arrange with the railway companies for the transaction of public telegraph business at the railway stations. A large number of stations were already available, but in many cases the railway companies did not possess the requisite facilities.

Australia.—During Lord Jersey's visit to Newcastle, New South Wales, he opened an extensive creamery, and although a full description of the works is not at present to be obtained, we notice, says the Australian *Engineering Journal*, that the building has been lighted throughout by the Electrical Material Company, of Bridge-street, Sydney, with incandescent lamps of 16 c.p., which are thrown into circuit on each floor by separate switches, every lamp being protected by a safety fuse, and each of the main circuits by a double-pole fuse and switch. The switchboard is a very neat-looking and complete one, being mounted, with all the necessary voltmeters, ammeters, safety fuses, and switches, on enamelled slate.

Arc Lamp Globes.—One of the favourite experiments at the schools is to set the students to measure the varying powers of the arc in different directions, which they generally manage to do, if they do not learn how to design a dynamo. Now this pleasure will be denied them, at any rate, if they use the globes of M. Frédureau, who has used the calculations once for all, and designed a globe of such a form and with prisms of such thickness that the light is distributed everywhere with evenness. The same idea is applicable to the bulbs of incandescent lamps, so that sideways or endways the filament shall give the same illuminating power. This may be advantageous in many circumstances, though, naturally, the cost of the globes is higher.

Secondary Batteries for Stations.—The use of accumulators in central stations has become so common and advantageous a method in this country, that it is a little difficult to realise that up to the present there has been no case of the kind in America. The first installation of accumulators for station use will be connected to the mains this week at one of the New York Edison stations. The cells are of the Crompton-Howell type, 51 plates to a cell, giving a capacity of 1,500 ampere-hours. The experiment, for so it is regarded, is being watched with much interest among American electrical engineers, as it is felt that the success of this installation may lead to the reconstruction of every direct-current station plant in the United States.

Montreal Sleighing.—Who has not resolved, if he ever gets the chance, to pass a winter in Montreal? It is a veritable ice fête from morning till night in the winter; what with ice palaces, sleighing, tobogganing, and snow-shoe tramps, winter passes comfortably and with exhilaration. A curious thing has arrived which would seem destined to put a stop to some of the gay amusements, and this due to the electric tramways. That these may run in winter, snow-ploughs are used which do their work so well that the road is spoilt for sleighing. A petition, signed by over 10,000 inhabitants, has been presented that the electric trams may be discontinued in winter, and such is the love of sport that it is possible a season arrangement of tram running may be requisite.

Belgian Telephones.—On January 1 the whole of the telephones in Belgium were taken over by the Belgian Government. The history of the telephone enterprise in Belgium, in brief, begins with the establishment of a number of exchanges by as many different companies at the time of the introduction of the Bell patents. In 1882 these companies were consolidated into one, under the title of the Compagnie Belge du Telephone Bell. In 1883 the Belgian Government gave a general authorisation to this company, reserving the right to take over by re-purchase the telephone business on January 1, 1893. The company have since tried to get this condition set aside in the courts, but their appeal was dismissed, and the State therefore took over the telephones at the beginning of this year.

The Anschutz Camera.—Those who are interested in the triumphs of photography may see, opposite Charing Cross Station, in the "Electric Wonder," an apparatus that will give them pleasure and amazement. Herr Anschutz, in a camera that takes any number of negatives from 18 to 25 per second, produces a series of realistic photographs, giving a succession of actions akin to the old zootrope effect. Mounted on a rapidly-revolving disc, each photograph as it comes opposite the eye is illuminated by an induction flash, and the result is a very lifelike presentation. Cavaliers, troops of solders, acrobats, birds in flight, and so forth, are seen exactly as in action. The machines are arranged on the penny-in-the-slot manner, and the constant rain of pennies testify to the intense interest of the public in the "Wonder."

Communication with Lighthouses.—The Commission appointed to investigate the subject of electrical communication with lighthouses yesterday finally considered an interim report, which will be published immediately. It receives her Majesty's sanction. The interim report deals with that portion of the evidence relating to the necessity of establishing telegraphic communication with lightships and lighthouses on the British coast, a question which was carefully considered by the Commissioners in the course of their visits to the coastlights during last autumn. It is understood that the interim report recommends experiments being made in the matter of direct communication between lightships, etc., and the shore, upon some of the most dangerous shoals and sands. Later on the Commission will consider the advisability of the general adoption of a scheme of communications.

Tramway Poles.—The prejudice against ugly poles does not belong to England alone—Canada has also protested against electric tramway abortions. The curious spectacle was witnessed a few weeks ago at Toronto of a brigade of axemen merrily chopping down the poles erected by the street railway company of that city. The agreement under which the concession was granted included a clause that the approval of the city engineer must be obtained. He did not approve of the rough, awkward poles that would have disgraced the streets of a backwoods village, more particularly when they were painted a variety of colours, the favourite being a glaring red. So one morning they were all chopped down. The incident serves to accentuate the need of the careful consideration of the average man's artistic feelings on the part of electric tram lines. It is a good augury on the part of English lines that the engineers of the Walsall line have taken this feeling into consideration.

Photography in Research.—An instructive lecture was given recently by Prof. Nichols, of Cornell University, before the Brooklyn Institute, on the use of photography in research work. In this he dealt largely with electrical research, showing photographs of electrical discharges and electric arcs. The photographs of the arc revealed some phenomena not perceived by the naked eye. Among these were the brilliant particles thrown off by the arc, and also the superior actinic effect of the arc when copper-coated. A photograph of an arc on an alternating-current circuit showed a succession of flashes, proving the intermittent character of the arc produced under these conditions. Photographing the reversals of current shown by a telephone diaphragm were not so successful as the method adopted of allowing a stream of mercury as conductor to pass between the poles of a magnet; this showed vibrations corresponding exactly to the reversals of the current, the curve produced being the sinuous curve expected.

Skating by Electric Light.—Acton can boast of being perhaps the only place in the United Kingdom where the electric light is utilised for skating purposes, for on Thursday a large number of residents and visitors availed themselves of this pleasure. The idea originated with Captain Ronald Scott, whose services in connection with the electric search-light have been recognised in the highest military quarters. The captain's electrical works are situated on Acton-hill, adjoining his residence, in the grounds of which is a large lake. Here the ice is about 4in. thick, and Captain Scott succeeded in illuminating the lake and its surroundings by placing a powerful light, communicating direct from his works, on the bank. The atmosphere was somewhat thick, but the light completely penetrated the fog, and made the surroundings almost as light as day, with the result that the large company of skaters were perfectly safe and comfortable, and enjoyed themselves up to a late hour.

Electric Furnace.—To those that are interested in experiments dealing with the behaviour of bodies at very high temperatures, the description of the modifications by MM. Ducretet and Lejeune and M. Cailletet of the electric furnace in *Electricité* (December 29) may be recommended. In the first a thick rod dips into a carbon block hollowed in the centre, embedded in firebrick some 6in. square. This is bolted to a slate base with mica sides, so that the operator can see inside. The length of arc is regulated by a screw, the current being 25 to 30 amperes at 60 volts. This can be used for melting of steel or other metals. The furnace of M. Cailletet consists of a very strong box of steel of about quarter-litre capacity, with cap through which the electrodes pass. A spyhole with thick glass is arranged opposite the arc. Gases under pressure can be introduced, the current for either arc or incandescent light turned on and the resultant compounds studied. A number of interesting experiments have been carried out with various gases under pressure, as well as the transformation of chalk into marble at great heat and under great pressure.

Johnstone Electric Tower.—The World's Fair without a high tower cannot be thought of, so the Johnstone tower is to be erected. In form it will be somewhat like a huge ornamental gasholder, rearing its head 560ft. into air. The base will be an ornamental pavilion with colonnades, while starting from this pavilion, in large spirals 230ft. in diameter, a double-track electric railway will lead to the top, which ends in another pavilion with restaurant and immense promenade, from which at night will flash six searchlights over the exhibition grounds. Cars of a handsome design, capable of holding eight persons, will be run in trains of five. The entire distance will be about 1¼ miles, the ascent taking about half an hour. The fare will be 2s.—half a dollar. There are to be 800 cars in all — 400 ascending, while 400 are descending. Outside the track will be a spiral garden of flowers, which will give colour to the white rods, girders, and spiral tracks. Each car will be lighted back and front by six incandescent lamps, and the marvellous sight will be presented every night of 400 cars circling down the outer track, while 400 are ascending at the same speed, causing 5,000 incandescent lights to flit past each other, twisting in and out in rapid succession. Stars and pendant lamps of various designs will outline the tower itself, which will present a magnificent spectacle. The cost is reckoned at a million and a half dollars, and at the fare proposed is estimated to yield a handsome profit. It will certainly be one of the great sights of the fair.

Crompton's Catalogue.—A very handsome, and withal business-like catalogue—is the judgment we pronounce upon the new book of "Notes, Data, and Prices relating to Dynamos, Generators, and Motors," just issued by Messrs. Crompton and Co., Limited. It is all that a catalogue should be: well illustrated, with abundance of carefully-arranged detail, notes upon the material, behaviour, and special purposes of the dynamos, and ended by some very weighty testimonials from official authorities, private gentlemen, central-station companies, and colonial users. Messrs. Crompton have gone in strongly for colonial representation, as, indeed, it is to the best interest of British electrical engineering that they should do; and their list of agencies comprise Australia, Hamburg, Transvaal, Canada, Rangoon, and Japan. A telegraphic code is first given, and then a handsome cut of the Crompton patent dynamo, rope gearing, as made from 70 h.p. up. The arc dynamos for high E.M.F. are next illustrated, and the example is quoted of one of these machines running 10 hours a day every day at 1,100 volts, and the commutator has been running for 2½ years, the brushes lasting about nine months. A full list of dynamos and motors is given with details and code words. A special point is made of steam-dynamos with Willans or Chandler engines, and the large dynamos now so much used for electrolytic work and welding are described. We notice that reductions in price have been generally made throughout. It is a catalogue which every engineer should hasten to possess, and we note that it will be followed by others dealing with lamps, accumulators, electric railways, and other manufactures undertaken by the company.

Science in 1892.—The *Times* in its review of science for the past year says: "Physics is the inadequate name given to a vast and varied department of science. It includes all the multifarious phenomena connected with electricity and magnetism, which in their theories and their applications engage quite as many workers as chemistry itself. We can only say that during the year there has been no slackening in the progress made in both directions. One of the most wonderful demonstrations during the year was Mr. Nikola Tesla's manipulation of powerful currents of electricity at the Royal Institution and the Society of Electrical Engineers. With Jovian recklessness he played with the artificial lightning which he generated, and made himself the medium of currents of such power as, according to accepted theory, ought to have killed a hundred men. This he could do, we understand, because he had discovered how to convert 'shocks' into a practically continuous stream of successive oscillations. He holds that a phosphorescent glow is the light of the future, and hints at artificial auroræ shedding their rays from the summits of towers of enormous height. A paper of considerable importance was given to the Physical Society (one of the most 'living' of our scientific societies) by Prof. Fitzgerald, on electromagnetic vibrations. Both at the Royal Society and at the Royal Institution Prof. Oliver Lodge, one of our most original and daring investigators, described his delicate researches as to the connection between ether and matter and the motion of ether near the earth, making us wonder more and more what this intangible something can be. The Electrical Exhibition at the Crystal Palace was a noteworthy event of the year."

Presentation to Mr. C. E. Spagnoletti.—A meeting was held at the offices of the Great Western Railway Company's Telegraph Department on the 28th ult. to present Mr. C. E. Spagnoletti, the late chief electrician to the Great Western Railway Company, with a testimonial upon his retirement from active service. The presentation consisted of a handsome illuminated address and several valuable articles of plate, subscribed for by the members of the telegraph and electric light departments. The chair was taken by Mr. H. T. Goodenough (Mr. Spagnoletti's successor), who, in requesting Mr. Spagnoletti to accept the handsome gift of the members of the department as a token of their high esteem, gave a short account of Mr. Spagnoletti's work in connection with the Great Western Railway. Mr. Goodenough claimed for Mr. Spagnoletti the title of "Father of Railway Telegraphy," he being the originator of, and the first to carry into practical effect, the establishment of a telegraph department as a branch of railway work. The chairman alluded to the exceptional ability Mr. Spagnoletti had displayed as the head of this department, and to the great value of his services as the inventor and improver of many forms of electrical apparatus which had done so much to promote the efficiency, speed, and safety of railway working. In conclusion, he said that Mr. Spagnoletti would long be remembered for the unvarying kindness, courtesy, and fairness which he had shown in the performance of his duties, and would carry away with him the good wishes of all those with whom he had been associated, and their earnest hope that he would long be spared to enjoy his well-earned retirement. Mr. Spagnoletti, after thanking the chairman and staff generally for their generous gift and the gratifying evidence of their appreciation and esteem, gave a brief *résumé* of his career, with special reference to the history and development of railway electrical appliances. In the course of his remarks he referred to the enormous value of electricity to the railway companies at the present day, the efficiency of the electrical apparatus enabling them to run a much quicker succession of trains than was possible under the old *régime*, and thereby multiplying their carrying capacity, and also enabling them to add considerably to the convenience and safety of railway travelling, thus inducing increased traffic. The chairman having suitably replied, several members of the staff spoke in praise of their old chief, and Mr. Spagnoletti having thanked the speakers, the proceedings terminated.

Simplification of Tesla's Experiments.—When reproducing Tesla's experiments, M. Schœntjes, professor at the University of Gand, has found that they may be reproduced with currents of quite low frequency, though the intensity of the phenomena is less. The ordinary method of carrying out these experiments in the classroom consists in charging a condenser by means of secondary currents from a first Ruhmkorff coil, and passing the discharge—rendered oscillating by a spark passing between the knobs of an exciter—into the primary circuit of a second coil immersed in oil. The currents generated in the secondary coil of this transformer are used to produce the Tesla effect. M. Schœntjes did away with the whole of this arrangement, keeping simply the first coil with an ordinary spring contact-breaker. The coil was 40cm. long and 20cm. diameter. The primary current was taken from accumulators. The following experiments were carried out: (*a*) The two poles of the secondary wire being free, a vacuum tube, with or without electrode, was lighted up when held by the hand or placed on a block of paraffin a foot or so from the coil. A vacuum tube held by one end in the hand was lighted by contact to one of the poles, contact not being necessary. The tube, insulated on a block of paraffin in contact with one only of the poles, became luminous. (*b*) One of the poles being free, and the other connected to a plate of sheet iron suspended from the ceiling by insulating supports: (1) By attaching to the free pole an exhausted bulb furnished with one electrode and a straight carbon filament, the filament became luminous, though very feebly; (2) vacuum tubes, Crookes tubes, and phosphorescent-powder tubes became luminous when held in the hand below or near the plate—they seem to go out when passed from one hand to the other along all their length; (3) the tubes became luminous when laid on a block of paraffin below the suspended plate. (*c*) The two poles connected by a wire with an air space for the passage of the spark of the direct induced current: a vacuum tube lighted up when held near the coil. (*d*) The same arrangement as for (*c*), but one of the poles is connected to the suspended plate: tubes lighted up near the coil, and under or near the plate. By using a Foucault contact-breaker, making only five oscillations per second, the preceding experiments still succeed. With a much smaller coil the phenomena occur with practically the same strength. One of the poles of the small coil can be touched with impunity by forming a chain of two persons holding a vacuum tube between them; one person touching one of the poles and the other holding a second vacuum tube in the free hand, both tubes will light.

Dissipation of Energy.—Mr. Nikola Tesla contributes an article on the dissipation of electrical energy of the Hertz resonator to the American *Electrical Engineer*. The apparatus being immersed in air or other discontinuous medium, there occurs a dissipation of energy by "sound-waves of electrified air." Owing to this dissipation the period of vibration of an air-condenser cannot be accurately determined. Mr. Tesla has already drawn attention to this important point. These waves are propagated at right angles from charged surfaces, even if heavily insulated. Assuming that the charge imparted to a molecule or atom by direct contact or inductively is proportionate to the electric density of the surface, the dissipation should be proportionate to the square of the density and to the number of waves per second. From a wire, with high-frequency currents the dissipation is not far from proportionate to the frequency, and increases rapidly when the diameter is small. A wire made hot in the ordinary way behaves in some respects like one the charge of which is rapidly alternating, the dissipation depending on curvature of surface. In his experiments Mr. Tesla noticed that the mica vanes in Crookes's instrument are repelled with greater force when the incandescent wire is exceedingly thin. This observation led Mr. Tesla to produce the spin in alternating electrostatic fields. When he first undertook to produce incandescence of a wire in a bulb by connecting it to one only of the terminals of a high-tension transformer, he could not succeed for a long time. He reduced the length of wire without result. It then occurred to him to make the surface as large as possible, yet the bulk small—taking an exceedingly thin wire—and on turning on the current the wire instantly fused. Two very thin wires attached to the terminals of a high-frequency coil are capable of giving off an appreciable amount of energy. The waves are conspicuous at distances of 6ft., and differ from sound-waves only by being electrified, and cannot be entirely stopped by interposition of an insulated metal plate. The "ringing" of a condenser is due to the presence of air near the charged surfaces. Further, when a disruptive discharge coil is immersed in oil, the surface of the oil is agitated. This is not due to the oil: it is the air above the oil which is agitated. The action of the air is shown in a curious manner, for if a pointed metal bar is held with the point close over the coil, a hole 2in. deep is formed in the oil by the molecules of air violently projected from the point. It seems that the dissipation of energy is more rapid when the resonator is immersed in air than in oil; and the dissipation owing to the presence of air renders the difference between magnetic and non-magnetic metals more striking. A resonator of magnetic metal behaves virtually as if its circuit were longer. The conclusion arrived at from his own and Prof. Bjerknes' experiments, lead to the result that air must be considered as a factor fully as important, if not more so, than the resistance of the metals.

Theory.—We are gradually progressing towards an all-embracing theory of electricity, though whether our finite senses will ever enable us to formulate a truly satisfactory theory or not is still doubtful—whether, in fact, we may find a Darwin or a Joule to throw all the facts into place and produce a generalisation as simple of comprehension as Ohm's law, or whether the theory will remain as a curve always approaching but never attaining perfection—this we hardly know as yet. In Prof. Lodge's "Modern Views"—now, we are glad to see, in a second edition—the "jelly-bag" theory of an ether—which Prof. Lodge now regards as equally proved as the existence of air—is developed to the attempted comprehension of non-mathematical individuals. Electricity, according to this theory is an entity — ether, in fact, in motion. An incompressible fluid movable by being entangled, so to speak, in vortex whirls, twisting and intertwining like the filaments of a sponge, the interspaces being conductors—is the material aspect of this vortex-ether theory. It is indeed possible that we may find that there exists one matter—this supposititious "ether" present—in vortex whirls which give the apparent property of stability and materiality, and all the other properties of matter, though to look round the rooms of our library, and think that our books are nothing but vortex whirls of ether is rather a stretch of imagination, even to a mathematical mind. The most mechanically perfect theory is that the ether, existent everywhere, turns or vibrates on itself without yielding and only in the completed circuit of conductor gives a certain "slip," this slip allowing the motion to exist throughout the circuit-space, and wasting a certain energy in friction in the conductor. The idea is fast becoming acknowledged, and believed, that the force of electricity, whatever it is, is existent outside the conductor in the air-space, and not inside, though again to a simple mind it is difficult to believe when one touches a wire that the shock comes from the air and not the wire. The theory that vortex whirls constitute matter receives a confirmation in an experiment of Tesla's given in his printed paper, though not mentioned in his lecture, and to which sufficient attention has not been as yet given, that a highly-vibrating stream of molecules behaves as a solid. Tesla took a long vacuum tube and lighted it by means of an induction coil. As the pressure of gas is diminished, potential varies, and we know by old experiment that the phosphorescent gas shows rings and black spaces. Tesla found that by using a high-frequency current these black spaces filled up with light and the phosphorescence took the form of a long string of light. This is susceptible to the presence of another body as the hand, or to a magnet; but this important point is, that if violently deranged by this attraction it vibrates exactly like a solid stretched wire, with well-defined vibrations. While under electric action of high frequency, then, gas attains some of the attributes of solid matter. When we have experimentally proved that matter is a stable vortex whirl of ether, and heat and other forces vibrations of them, perhaps we have have a definite theory, not only of electricity, but of ether and matter itself.

LONDON CHAMBER OF ARBITRATION.

BY S. FLOOD PAGE.

Having been invited by you to write a short paper on some question affecting our industry, the choice of the subject being left to my own discretion, I have ventured to select a topic which is not likely to have been chosen by any other of your occasional contributors. I may anticipate one objection to the subject which heads this paper—namely, that it has no direct or special application to the electrical trade; but as a matter of fact it has both special and direct application to every branch of commerce, and to the electrical as to all other trades. It is common knowledge that not many "commercial cases" are now tried in the courts, and that a vast proportion of commercial contracts have inserted in them what we all know as "an arbitration clause." Recently the Lord Chief Justice, though not having much confidence in the remedy, consented to sittings of the judges in the Guildhall, but few City of London cases were taken there, and it seems to be generally agreed that the move to the Guildhall has not attracted the commercial cases which it was intended should be tried in the City. I must confess that from experience I have personally disliked the old-fashioned arbitration, and having been rather severely bitten some 15 years ago, I have never since inserted "an arbitration clause" into any contract from which I have been free to omit it. My notion of an old arbitration before a lay arbitrator, with first-rate counsel, with rooms to be hired at some hotel, with sittings arranged often for only a portion of a day, to suit the convenience of counsel, is that it has proved a slower, more costly, and less satisfactory method of deciding a business difference than an ordinary action in the courts.

Not very long ago I was in the chambers of a very able Queen's counsel, and on his table was the record of the one hundred and seventy-eighth day in a great arbitration case. When first the London Chamber of Arbitration was brought to my notice, I was somewhat sceptical as to its advantage and as to its efficiency, popularity, and success; but I have studied the question in all its bearings, so far as opportunity has presented itself. I have discussed it with warm supporters, with doubters, and with those who did not believe in it, and I have come to the conclusion that the London Chamber of Arbitration, based as it is on the Arbitration Act of 1889, is not only worth trying, but is very likely indeed to afford all those who are engaged in commercial pursuits—and who are therefore, alas! liable to become entangled in commercial differences and disputes—a cheap, speedy, reasonable, and hopeful method of settling all such commercial differences. Of course, there will still remain differences of principle, patent questions, rights of property too vast, too important to be put to the test in any other court than that of the able and impartial judges of the Supreme Court of Justice. But commercial life, like everyday life, is far more made up of trifles than of big events. Disputes arise involving only questions of pounds, and not very many pounds, that, while vexatious, are not worth spending twice as many pounds over as the amount of the claim. Such differences can be referred to the London Chamber of Arbitration, with a reasonable hope that they will be settled by experts, in a few hours, at a small expense, the proceedings being conducted in private, by the principals themselves, or their agents, or clerks, without the intervention of counsel or lawyers, and settled on sound commercial principles, without very much legal technicality. For more important cases, counsel may be employed and a legal assessor may be paid to assist. Not many days ago, an influential member of one electrical industry told me that he had on that day inserted a clause in a contract to the effect that in the event of any dispute it should be referred to arbitration, under rules of London Chamber of Arbitration. He gave as a reason for so doing, that he had had a dispute involving only £14 in money, that circumstances led to this case being tried in court, that he had been kept hanging about the court three whole days, and that eventually the case was decided on a legal technicality which did not touch the merits of the claim. I have recently suggested the same reference in a small trading difference which has arisen. I venture to urge all who are engaged in the commercial application of electricity to consider whether it will not be advisable to insert "a London Chamber arbitration clause" into all future business contracts, into contracts for supply of machinery, of installations, of wiring houses, etc. I must not enlarge upon the method of procedure, upon the hearing, the selection of arbitrators, or upon the many interesting details connected with this new departure, for which we have to thank the Corporation of London and the Council of the London Chamber of Commerce. I will only add that the first case has actually been heard under the new rules, and that it lasted about two hours, and cost only about £4. That the new Chamber of Arbitration supplies a commercial want seems shown by the fact that Sheffield, Nottingham, and other commercial towns are already taking steps to carry out similar local chambers of arbitration. I commend this subject to the thoughtful consideration of all who are engaged in electrical commercial enterprise.

NOTES ON AMERICAN PRACTICE.

BY PROF. G. FORBES, F.R.S.

Electric Traction.—I propose to jot down a few of the notes I have made, and, first, some on electric traction in the United States. Some of these things may not be new to all who read this, but most of the points I propose drawing attention to can hardly be studied except on the spot.

With regard to rails, the tendency is everywhere to increase the weight, and to go to 80lb. or even 90lb. a yard. A large part of the weight of the motors is generally supported on the axle, and this increases the wear of rails. Cases are quoted where a dummy steam locomotive wore the rails at the joints less than an electric car of the most usual type. This is owing to the jolt due to the weight of the motor on the axle, only partially relieved by springs.

The types of car most generally used are (1) a two-wheeled car with 6ft. wheel base and a 15-h.p. motor on one axle, or two 15-h.p. motors on the two axles; (2) car with two bogies, one carrying two motors and the brakes, the other carrying nothing; (3) the radial car. This last is a long car with a pair of wheels at each end (the axle of each being mounted on a vertical pivot), and a central pair of wheels with girders to allow a movement of the wheels and axle transverse to the car in going round corners. There is no settled system of springs. All kinds are used, and in all sorts of positions.

The gearings are (1) the old double-reduction gear, which has almost disappeared, which rattles in a most objectionable manner after a few months' wear, and which consumes a vast amount of power; (2) the single-reduction gear, which is very generally used, especially with what is called the W.P. (waterproof) motor, completely enclosed in cast iron; (3) the Short gearless motor, which has not come largely into use, the chief objection being the difficulty due to magnetic side pull, which heats the thrust bearing; (4) there is also the Eickemeyer car, in which the two pairs of wheels are connected by a coupling-rod, which is driven by a motor with a flexible coupling, the motor being wholly supported on springs. Numerous attempts have been made to run motors with the armature fixed on the axle; but there are obvious sources of trouble, and this has been definitely abandoned. Destruction of insulation, breaking of wires and of axles, and deterioration of the wheels, have been the chief sources of trouble. It is a pity to see this experience thrown away on the South London and on the Liverpool Overhead Railways.

About the motors I have not much to say. Mr. Eickemeyer winds his exciting coils in the only rational way—that is, round the armature, where we want the magnetism, as I recommended at the Institution of Electrical Engineers in 1878. He thus saves a quarter of the weight of materials. This motor is used exclusively for the Otis elevators. Mr. Eickemeyer is the only constructor who uses my carbon brush in a proper way—*i.e.*, employing a large number of carbon contacts, each with an independent spring. Most makers are using armatures with Pacinotti teeth cut very deep. A great practical advantage is claimed for them—viz., that you can roll them along the floor without hurting the insulation. The shaking that tramcar motors are subjected to often causes injury to the commutator. The repairing shops generally have several commutators under repair from this cause. To correct this, Mr. Short makes the metal support of the commutator bars in one piece with the spider. In Elihu Thomson's waterproof motor the weight of the armature is supported by the upper pole, round which alone the coils are wound.

Scores of accounts have been published about the cost of working electric tramways; but I have never seen one which included a proper depreciation account and sinking fund for replacing motors, etc., and renewing the rails and the earthed conductor. [I find that the disintegration of this last by electrolytic action is really a serious matter in some cases.] So far as I can see, motors are replaced by new types every few years, so the sinking fund should be large. On one line they had 50 to 75 armatures burnt out per year, but this does not happen now, as they put motors of 30 h.p. to do an average of 10 h.p. or 15 h.p. In published accounts you frequently see all the repairs included, but as generally the plant has been at work only a year or two, this does not give a fair notion of the depreciation. The cost of coal in a table I have before me relating to 30 street railways varies from ·016 of a cent to 2·4 cents per car mile, the cost of coal varying from 1.20dol. to 5dol. per ton of 2,000lb. Using natural gas in one power station, the total expenses in the power station came to 15·9 cents a day per horse-power. Using piped oil at 42 cents a barrel of 42 gallons and 2 cents for haulages, these expenses were 16·6 cents a day. The oil is burnt as fuel in the furnaces of tubulous boilers. Rooney's mechanical stoker is largely used, and spoken of highly by both workmen and managers. It enables them to use cheap slack coal.

I obtained data in several places as to cost of putting down electric railway plant. Car motors on their frame complete used to cost 3,300dol. They have been supplied at 2,000dol. and 1,800dol. early this year, and I heard lately that tenders were in at 1,000dol. The following data apply to a fairly representative station: Total expenses from 67 to 80 per cent. of gross receipts. Total cost of a power station handling 70 cars, with a reserve of 10, is 98,000dol. Trolley wire $\frac{5}{16}$in. diameter is used, costing 15 cents per pound; 30ft. wood poles, 800dol. per mile; iron poles, 3,000dol. per mile; rails, 70lb. per yard, at 1.06dol. per foot; total cost of laying rails ready for paving is 10,000dol. per mile; body cars cost 850dol. to 1,000dol. Of course these prices vary, but I think these give a fair idea of an average station last summer. Taxes are often a serious item.

Electric Conduits.—I find among my notes some facts about the cost of laying conduits in New York. As is well known, the plan is to have a number of iron pipes laid in a trench and filled up with concrete. These are 3in. wrought-iron pipes. The insulated cables used are generally No. 4 B. & S. vulcanised rubber lead-covered, costing 25 cents per foot and 1·5 cents per foot to draw in, joints 1.50dol. to 2.50dol. each at distances of 250ft. Four cables can be drawn through it together on a length of 400ft., and any one can be drawn out and replaced. This means that the section of cables is about one-sixth of the section of the pipe. The manholes are square, $8\frac{1}{2}$ft. each way. Mr. Horatio Foster gave me some carefully worked out figures as to the cost of laying these pipes or ducts. Of course the cost of a duct per foot is less when the trench contains a large number.

Trench complete, 3ft. wide and 5ft. deep, including unpaving, repaving, digging, refilling, carting away surplus, and repairs for one year, per foot run ...	$0.65
Cement and sand, four to one	0.55
Boards to retain cement...............	0.10
Labour on cement and sand	0.50
	$1.80
Cost per foot of 24 manholes per mile..................	0.87
	$2.67

Manholes 7ft. deep, 8ft. 6in. square inside, walls 12in. brick in cement, 338 cubic feet brick at 21 bricks per cubic foot = 7,098 bricks at 20dol. per 1,000 laid.

We thus have—

Bricks	$142.00
Top castings, 1,500lb. ...	50.00
	$192

24 per mile	4,608, or $0.87	per foot	of trench.
3in. iron pipe	0.24	„	„
Carting, piling up, laying, and jointing..............................	$0.01\frac{3}{4}$	„	„

From these data the following is the cost in dollars per foot run of trench, manholes, pipes, etc.

No. of ducts.	Pipes.	Trench.	Man-holes.	Total.	Con-tingencies 20 per cent.	Total.	Per duct per foot run.
2	0.52	1.80	.87	3.19	0.63	3.82	1.91
4	1.03	1.80	.87	3.70	0.74	4.44	1.11
6	1·55	1.80	.87	4.22	0.84	5.06	.85
8	2.08	1.80	.87	4.75	0.95	5.70	.71
10	2.60	1.80	.87	5.27	1.05	6.32	.63
12	3.12	1.80	.87	5.79	1.15	6.94	.58
14	3.64	1.80	.87	6.31	1.26	7.57	.54
16	4.16	1.80	.87	6.83	1·36	8.19	.51
18	4.64	1.80	.87	7·31	1.46	8.77	.49
20	5.20	1.80	.87	7.87	1.57	9.44	.47
24	6.24	1.80	.87	8.91	1.78	10.69	.44
30	7.80	1.80	.87	10.47	2.09	12.56	.41

The following are the actual costs in 54 cases of leading subsidiary connections into houses on Third-avenue. The average length of these is 52·4ft. Separate accounts were kept for a set of 29 and a set of 25.

	Cost per foot for single pipe. For 29 cases.	25 cases.
Labour	$0·623	0·574
Pipe, 3in. lap weld	·23	·23
Cement and sand......................	·039	·048
Extras, bends, etc.	·114	·039
Repairs on pavement for one year	·149	·148
15 per cent. to contractors	·173	·155
	1·328	1·194

Average 1·26dol.

The average cost per subsidiary connection was 66·02dol.

Designing.—I take this opportunity to state an exceedingly useful rule for approximate estimate of loss of energy in heating copper conductors either on a line or in the design of dynamos: "At a density of 1,000 amperes per square inch, every 1,000 cubic inches uses up 1 h.p.' If the density is increased, the horse-power is increased in the same ratio. The above rule is easily remembered, and is close enough for most preliminary calculations, but by using 1,100 instead of 1,000 for the number of amperes or for the number of cubic inches, a more accurate result is obtained.

In the design of dynamos and transformers we often want a piece of metal, mechanically strong, which will not heat much with Foucault currents. Nickel steel, with 25 per cent. of nickel seems very suitable. It is ordinarily non-magnetic, but if once cooled to a very low temperature it is tolerably magnetic till it is again heated to a high temperature. The non-magnetic material has a higher electric resistance than any metal or alloy commonly used by electricians, and its mechanical strength is enormous. It has been experimented on by Dr. Hopkinson (Royal Society *Proceedings*), but I could get no definite information about its hardness. Lately I got some cast in America, and its hardness is far too great to allow it to be machined. I have other specimens with a smaller proportion of nickel, which tool easily. It is poorly magnetic. It is used by the Compagnie de l'Industrie Electrique for binding together the iron discs of large armatures for multipolar machines. There are many parts of machines where this material ought to be used.

STANDARD CELLS AND TESTING BATTERIES.

BY DESMOND G. FITZGERALD.

Within the last few years much good work has been done in connection with the Clark standard cell, considered from a scientific rather than from a purely practical point of view. Even an electrician may pause to admire the delicacy of apparatus that will determine differences between two cells of two or three ten-thousandths, or even two-millionths* of a volt. But from the point of view of the practical worker, more permanence and less liability to accidental damage in the cell itself, together with some considerable capacity for giving and taking current, would be a desideratum, even if accompanied with less accuracy of agreement between the cells. From the same point of view, the paper read by Mr. Latimer Clark so long ago as June 19, 1873, would still be of interest, and in many cases might possess even the charm of novelty. Comparatively few, in fact, amongst the rising generation of electrical workers are practically aware of the ease and accuracy with which not only potential differences, but also currents and resistances, and even electrostatic capacities and the horizontal component of terrestrial magnetism, can be measured by the aid of a suitable standard cell.

In spite of the vexations and disappointments with which Clark's cell punishes any lack of due care and attention to details in its construction, no couple has yet been brought forward that can compete with it in point of accuracy. It is perhaps natural for us to condemn it when, by inattention to the purity of our mercury or sulphuric acid, we have mingled lead sulphate with our mercury protosulphate, and are endeavouring to account for the low readings on the hypothesis that the zinc sulphate solution *must* be supersaturated; but when the offending lead-salt has been removed by caustic potash and the mercurous protoxide has been reconverted into sulphate, it is natural also that we should recall our verdict whilst constating the absolute agreement of the cells made up under the improved conditions. The instructions contained in the Board of Trade memorandum are, so far as they go, sound, with the exception, I think, that they perpetuate the plan of bringing the zinc into direct contact with the undissolved mercurous salt. This, for which there is no necessity, brings about local action which tends to shorten the life of the cell, and may also diminish its E.M.F. In all the cells I have constructed of late years on the old plan of resting the zinc element on the mercurous paste, I have taken the precaution of separating them by means of one or two roundels of filter paper.

But however it may be in the quietude of the physical laboratory, it is intolerable in practical working to have a cell so constructed that it must be moved with precaution, and cannot, without danger, be tilted to an angle of 40deg. Credit is due to Dr. Carhart for having endeavoured to remedy this condition of things by the introduction of a diaphragm separating the mercury and sub-sulphate from the zinc element. In a recent issue of *La Lumière Electrique*, this diaphragm is stated to be formed partly of asbestos and partly of cork, the latter of which, at least, would appear to be singularly inappropriate for the purpose in view. Dr. Carhart has also essentially modified the principle of construction by substituting for the solution of zinc sulphate, with excess of heptahydrated crystals of the salt, as used in the Clark cell, a solution saturated at 0deg. C., and, therefore, non-saturated at temperatures above freezing. It is still an interesting subject for discussion whether this innovation is likely to be an improvement or the contrary. To my mind, the objection first brought against it by Lord Rayleigh appears almost conclusive. So long as the solution remains of the given strength, we have a standard cell which is not Clark's cell, but one with a higher E.M.F. at temperatures above freezing, and possibly a better standard cell. But if, through leakage or otherwise, any evaporation takes place, we are on unknown ground, or, rather, altogether at sea. And the difficulty is that we can seldom be quite certain that no evaporation has taken place, and that the initial strength of the solution has remained constant. Whereas with Clark's cell, although time may be required for diffusion when the temperature rises, the conditions are such that we may assume that the solution is saturated whatever may be the temperature.

In some cells which I have prepared recently, I have followed in all essential particulars the instructions contained in the memorandum of the Board of Trade; but I have constructed them with a diaphragm in such manner that the cells may be inverted without detriment. The diaphragm that I have found most suitable is formed, wholly or in part, of a transverse slice of chemically-treated ratan cane.

With some valuable assistance from Mr. J. MacKenna, I have for several months past been carrying out a series of experiments which lead to the conclusion that, although it is very questionable whether any combination that has been tried can rival the Clark cell in point of accuracy, there are some other couples which, in certain cases at least, can be used practically as standard cells with advantage. And in the construction of batteries for testing, or, generally, for purposes which do not necessitate a large expenditure of current, one or two amongst them appear to realise the ideal of a "waiting battery" and conditions of portability, permanency, and power which I have hitherto considered to be unattainable. On a future occasion I hope to justify these conclusions by an experimental demonstration; but for the present I must content myself with having drawn the attention of your readers to a subject which may be of interest and importance to at least some amongst them.

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* *Vide* Mr. J. Swinburne's paper read in Section A of the British Association, August 25, 1891.

THE DISTRIBUTING MAINS OF ELECTRIC SUPPLY COMPANIES.

BY E. R. DOLBY.

The various methods of laying distributing mains for electricity have received much attention in the past, and it is probable will receive still more in the future. Results have been produced in practice which were not dreamt of when the various distributing systems were first designed, and dangers have shown themselves present where the construction of the line was considered to be all that could be desired. The large sums of money which have now been spent by the public supply companies upon the underground network give the question of security very great importance. When we examine the reports of a few of the companies in the metropolis we find the following results, in which the percentage is reckoned upon the gross capital expended by the different companies, and represents the cost of mains, conduits, main-laying, and accessories, such as insulators, etc.:

	Per cent.
St. James and Pall Mall Company	31·4
Westminster Electric Supply	45·0
Chelsea Electricity Supply Company	24·0
Kensington and Knightsbridge	36·25

The average of these four gives us 34·16 per cent.; it is therefore clear that over a third of the total expenditure has been disbursed in underground work. We have purposely left out of consideration any figures relating to companies supplying alternating currents, as our future remarks only apply to direct-current supply. Anyone who has had much to do with electric lighting where the current is obtained from the mains of public supply companies, is well aware of the leakage which takes place on the street mains. A simple experiment may be performed by attaching a wire to one pole of a switch on the consumer's circuit, and another piece of wire to a gas-bracket, or water-pipe, so as to make a good earth. One, two, or more lamps, suitable for the potential on the house circuit, may then be lighted in parallel between the two wires. The leakage which is continually going on to earth must of course have some effect upon any metal which is lying in the earth near the electric mains. The disastrous accidents which have occurred in Paris, and the less serious ones which have happened near the mains of the St. James's and Pall Mall Company in London, make it necessary to carefully consider the effects of such leakage.

In one instance in Paris an explosion of gas took place near an electric main, and it was found afterwards on strict examination that 52 branch lead gas-pipes in the neighbourhood had been pitted and punctured. The cables were insulated and laid in earthenware conduits, but it has been proved that although the insulation was fairly good at first, it became gradually worse and worse as time went on. Various theories were propounded to explain the causes of the explosions, and the facts of the case appear to be that if great care is not taken the insulation of the cable deteriorates continually. Whether bare copper is used on insulators which allow the moisture to reach the conductor, or from defects in the insulating covering of the conductor itself, as soon as a leak is formed electrolysis is set up, and the earthenware conduits become partial conductors.

A careful examination of the conduits showed that the material was quite altered: a deposit of soda, potash, and the carbonates of sodium and potassium had taken place in the interstices of the earthenware. These deposits are due to the electrolysis of the alkaline matters contained in the soil and to the absorption of carbonic acid from the atmosphere. A considerable quantity of lead, and copper to a less extent, was also discovered. From experiments which have been made in Paris it has been clearly proved that if the lead gas-pipes be positive, and in the near neighbourhood of the negative conductor of electricity, then, although there may be no leakage at first, if once such a leakage be set up, the surfaces of the lead pipes become whitened by the action of chlorine, and the metal is eaten away and pitted. This pitting may not cause a leakage of gas, but it is obvious that perforation of the lead pipe is merely a question of time. The action is not caused by fusion of the lead, for the leakage currents do not usually become sufficiently great.

Passing now to the cases which occurred near the mains of the St. James's and Pall Mall Company, we find that similar results were produced. In one case the back of a gas-meter, in contact with a damp wall, was eaten away into holes, and in the other case a lead water-pipe was pitted in a similar manner. Major Cardew reported at the time that the effects were due to the condition of the pilot wires in the conduits, and recommended that they should be removed. It is somewhat difficult to see why the pilot wires should have been the cause, but it is obvious that in some cases the insulation of the conductors is not permanently satisfactory.

We believe that trouble will yet be experienced with high-tension direct-current mains laid in split earthenware pipes without special insulators of any kind, but this class of distribution is as yet comparatively new.

METAL VERSUS WOOD CASING.

BY W. B. SISLING.

The methods of wiring buildings are going through a process of evolution, and we may already trace some indications that wood casing is to be partially or entirely superseded.

When the durability of rubber could not be relied upon each wire was run in a separate groove in wood casing, with the special object of increasing its insulation. This tended to encourage the use of cheaply-insulated wires, reliance being placed upon the insulation secured by the wood casing. It was only in low-class work that this tendency was conspicuously developed, but reliance on wood insulation is unsatisfactory, and may be dangerous if moisture obtains access to the wood.

Risk of fire would best be obviated by encasing each pair of wires in a metal tube connected to earth, relying entirely on the covering of the wires to insulate them from one another and from the earthed tube containing them. This would tend to ensure the use of high-class wires covered with vulcanised rubber or other durable insulation, since cheap wires, if fixed in this way, would not test well. Faulty insulation would thus be much less likely to occur, and even if moisture should find out a weak point all risk of fire would be prevented by the metal casing.

Fires from defective wiring are rare, but a considerable proportion of those which occur are caused by a small but persistent leakage through damp wood casing. If the wires are run close together a small leakage cannot persist, as it increases almost instantly, and thus cuts off the faulty wires by melting the fuses at their roots.

In connection with distributing fuse-boxes, from which many pairs of wires radiate, the use of wood casing with a separate groove for each wire is difficult and clumsy, though this difficulty was not felt in the older "tree" system, in which each branch was jointed or "teed" on to the main wires at the nearest convenient place. These joints, however, were undoubtedly weak points, depending so much on the care and skill employed in making and insulating them. There is no difficulty in making good joints; the difficulty consists in avoiding a small proportion of bad ones, owing to various causes which it seems scarcely possible to eliminate entirely where many men are concerned.

Metal tubes are relatively easier to use in connection with multiple fuse-boxes than wood casing, as they are so much less bulky, and they are in many cases preferable. It is, however, often inconvenient to draw the wires into tubes, and it would seem that what is wanted is a metallic casing just large enough to contain the insulated wires, with a metal cover which can be easily applied and fixed after the wires have been placed in position. This would not only be safer than wood casing, but would also be neater, and thus tend to decrease the difficulty of wiring decorated rooms.

There are at least three different ways in which these requirements might be met. Firstly, twin wire might be made consisting of two well-insulated wires sheathed in lead. The insulation should preferably be such as would not be dependent upon the exclusion of moisture by the lead sheathing. Secondly, each pair of wires might be fixed in or upon a trough or strip of metal already fixed in position, and this metal strip could then be burnished over the wires so as to enclose them. Thirdly, rolled iron or steel casing and covering might be made without any central division, with stampings for the various bends and tee-pieces required.

POPULARISING ELECTRICITY.

BY H. J. DOWSING.

Perhaps some will say electricity does not want popularising; it is popular enough to all who can get it. We have only to offer the means of supply, and everybody will take it. My experience teaches me, however, that this is far from true. Everybody would like electricity, but few are willing to pay for it. Many look upon the electric light as being very pretty, but entirely out of their reach. This idea of expensive luxury "only for the rich" is fostered to a large extent by the gas companies who have given up denouncing the electric light as being impracticable, and taken to the more convenient manner of putting it out of court by magnifying its expense. Few people have time or opportunity to give the matter fair consideration.

If gas costs, say, £10 per annum, electricity will cost £20, so they say, forgetful of the fact that every user of gas pays nearly 50 per cent. more than he need do merely for the convenience of keeping lights on in rooms where they are not actually used. With the electric light, of course, there is no necessity for keeping the lights going when out of the room, and by careful users they are always extinguished, as there is no trouble to relight them. If the cost of the electric light is considered on this basis, it will be found that at the present price charged by the supply companies it does not often exceed gas to more than one-third. Then, of course, there are by-savings in decorations, and last of all the doctors' bills. But how is the general public to have these matters brought home to them? They do not read technical papers nor any books containing this information. Exhibitions have up till now been the only means of affording information on this subject, but even at these places practical instruction is seldom given. But why, some may ask, is it necessary we should trouble about instructing the people in this manner, why not leave the schools and science classes to teach the growing generation the value of electricity in the household? We might do that, but the industry at large will suffer. What we want is for every town throughout the country to take up this matter, and either themselves obtain powers or afford assistance to others to do so, and erect central stations for public supply. The governing bodies, such as local boards, town councils, and others, are made up of the general public, and often consist of successful tradesmen and others who have no time to study scientific subjects, and are simply swayed by the popular element which elects them.

If, therefore, the general public is influenced in favour of electricity, there will be no difficulty whatever in the way of inducing the local authority to aid electrical enterprise. The local gas companies saw this at the advent of electricity as a lighting medium. I know of one town which will serve as a sample of the action of these gas companies in attempting to thwart any schemes for introducing electricity in the neighbourhood. The managing body of this particular gas company took no interest whatever in local affairs until electric lighting appeared on the horizon. Then they awoke from their slumbers, and appeared to take a wondrous interest in everything going on in the district, and the managing director and the other large shareholders eventually put up for election, and obtained seats on the local board. Any enterprising member now who dares to suggest that electric lighting might be an advantage is met by the gasworks representatives with any amount of objections, which, of course, the proposer, who is not usually well-versed in the subject, cannot refute. Again, if there happens to be an enlightened majority on the Board, the gas company's shareholders and representatives often have sufficient influence in the district to turn a considerable section of voters against the matter, and so cause the local body to abandon the scheme.

As it is of the utmost importance that the public should be enlightened on the subject of electricity for lighting and other uses in the household, I think that either a society like the Institution of Electrical Engineeers or the London Chamber of Commerce should take up the matter, and afford facilities for giving the information desired. I think the best step to take would be to organise a system of popular lectures, which should be as little scientific as possible, and these lectures should be given in the chief towns throughout the country. The lectures should be, however, well illustrated, and go particularly into the question of cost.

From my connection with the technical education scheme in one of the home counties, I am perfectly sure that all committees who have the arrangement of scientific and other lectures would be only too glad to welcome such lecturers in their districts, and afford them every facility. Such a scheme as I have proposed need not be very expensive, as the lecturers' expenses would often be paid by the districts to which they went. I should think it would be well worth the while of the principal companies engaged in electric lighting to subscribe a certain sum per annum, and have the right of a lecturer's services on favourable terms wherever they may require them. The lecturer would not go into the technical details as to the systems to be employed, etc.; this could well be left to experts or the company who may have the matter in hand. I am certain that a good plain talk to a large body of the ratepayers would be of the utmost use in negotiations which unfortunately often fall through owing to the want of support the local authority receives from the ratepayers themselves.

The lecturers engaged under this scheme might be available for lectures at educational schools where only theory is known at the present time. The want of the age is practice. A good practical lecture is seldom designated dry, whereas a highly scientific one is only understood by a very small portion of the audience. It is extraordinary the amount of ignorance prevailing among well-educated persons as to how electricity is generated at the present time, and it only illustrates one of the many superstitions connected with the generation of electricity to say that some people will not believe but that we manufacture electricity from the air, and consequently rob it of its life-giving properties. Such erroneous impressions as these could easily be proved to be false. There is no doubt that the present is an opportune moment for such a crusade as I have already mentioned. The technical education of the youth of the country is now being well looked after, and the county council lectures are on the whole very popular.

Many local authorities who obtain powers, but are wavering in their attitude, and do not care, as they say, to risk the ratepayers' money, would soon be urged on if the ratepayers themselves were convinced of the advantage of having a supply station in their midst. Such an extension of electric lighting as would be brought about in this manner would be to the advantage of the industry at large, and the work of laying the mains and building the stations, and supplying the machinery, would give employment to many thousands who are now calling for work. Electrical supply is the only business which promises great growth in the near future, and the sooner the benefits to be derived from the use of this subtle power are known, the sooner will the work of more rapid extension commence.

THE MANUFACTURE OF ELECTRICITY IN THE FUTURE.

BY A. A. CAMPBELL SWINTON.

Speculation as to future developments of scientific discovery and invention must necessarily partake somewhat of the nature of fiction of the Jules Verne order, and to those who are content to consider only those things that in reasonable probability will become commercially practicable in the immediate or near future such speculation may appear to be but waste of time. To such as hold this narrow and short-sighted view this brief paper is not addressed.

If we exclude the very limited number of instances in which water or wind power is available, practically the whole machinery of the world is at present operated by steam-engines, or by allied engines consuming gas or oil. Every engineer is aware of the deplorable inefficiency of the steam-engine. Even the best engines of this class do not return in the form of useful work much more than 10 per cent. of the potential energy of the coal burnt in the boiler furnace. The other 90 per cent. is lost. Some goes up the chimney, some is radiated and conducted away from the boiler pipes and engine, the remainder escapes with the exhaust steam. Steam-engines are no doubt better in this respect than they used to be, and seeing the immense amount of time and skill that has been expended on their improvement, it would be strange if they were not so. Still, however, the results of all this labour, as above stated, are not very grand, and though further improvement is still possible, the inexorable laws of thermodynamics unfortunately render it altogether improbable that we shall ever see steam-engines with an absolute efficiency of 20 per cent. In other words, so long as we have nothing better than steam-engines four-fifths of the energy contained in the fuel that we consume in our prime motors must inevitably be lost. Nor is it very much better with the other heat engines that consume gas or oil. In their case there is indeed more room for improvement, but even with them an absolute efficiency of 40 per cent. is far more than the most sanguine inventor can ever hope to attain. To the electrical engineer, accustomed as he is to dynamos and motors of over 90 per cent. efficiency, these figures cannot but present a sad spectacle.

Now this lamentable inefficiency of all existing types of heat engines is an inevitable result of the so-called second law of thermodynamics, which applies to all heat engines whose working is dependant upon differences of temperature. There are, however, other possible means of producing power from fuel, which, as they operate on different lines, avoid this law, and consequently admit, theoretically at all events, of much higher efficiencies. When an electromotor is driven by means of the current from a galvanic battery, zinc is consumed in the battery in proportion to the power developed by the motor. The consumption of zinc is, in fact, analogous to the coal consumed in the boiler of a steam-engine. Differences of temperature, however, have nothing to do with the results, and consequently the second law of thermodynamics is not involved. Such a combination, therefore, is capable of a far higher efficiency than any steam or other heat engine, and, as a matter of fact, with such an arrangement over 70 per cent. of the heat energy developed in a battery has been obtained experimentally from a motor in mechanical work, and this when working on a very small scale. It will, however, manifestly always be far too costly to use zinc as fuel in this manner, and before any such arrangement can be made to compete with existing heat engines, some form of battery or other apparatus must be devised that will produce electricity direct by the consumption of coal either in its natural state or in the forms of coke or gas.

In order to show that this problem is not really so insoluble as it may appear, it is only necessary to mention Grove's gas battery, which operates by the consumption of hydrogen gas, and the batteries of Becquerel and Jablochkoff, in which the electricity was produced by the consumption of carbon. Here indeed is a grand opportunity for the scientific inventor. For the man who succeeds in solving this great problem there is wealth beyond the dreams of avarice. The discovery of a commercially practicable means of the direct production of electricity from coal with a fair efficiency of, say, only 75 per cent.—and this is perfectly possible—would revolutionise the whole mechanical world. It would do more: it would do away once and for all with all smoke and fog in our large towns, it would lead to the total abolition of fires and chimneys, it would render unnecessary the transport of fuel. Generating stations established in the coalfields, perhaps at the bottom of the coal-pits, would supply electric currents of small amperage, but immense potential, which would be distributed throughout the country and conveyed to all towns. At convenient points these would be transformed down and further distributed. Eventually the points of application would be reached, and power, light, or heat would be obtained. The saving would be immense. All cost of transport of fuel would be avoided, for power purposes an efficiency far surpassing that of the best existing steam or gas-engines would be obtained; even for heating, taking into account the inefficiency of modern arrangements, electricity would supersede coal on the domestic hearth.

The picture is a fascinating one. It can scarcely be doubted that in some way or other it will be realised some day. The only question is, when?

LUMINOUS DISCHARGES.

BY E. C. RIMINGTON

As the illumination of electrodeless vacuum tubes has been brought forward rather prominently during the past year, principally through the experiments of Tesla, the writer, in response to the request of the editor for a short article, thinks a few words on the subject may prove of general interest.

The cause of the illumination of an exhausted tube is a suddenly-acting electric stress in the dielectric, formed of the rarefied gas inside the tube; if the stress be great enough and applied with sufficient rapidity, the rarefied gas, being a weak dielectric, gives way, and a convection current passes in the tube. The luminosity produced is probably due to the molecules of the gas colliding with increased velocity, these collisions causing the molecules to vibrate in parts (somewhat analogously to the prongs of a tuning-fork), and to give out ether waves short enough to affect the retina of the eye; or it may be that the electric equilibrium of the molecules is upset by these collisions, and their charges caused to oscillate, thus giving out electromagnetic waves of short enough wave-length to be called "light." The effect just described may be produced in three ways.

1. By placing an exhausted tube in a rapidly-varying electric field. This is what happens when a vacuum tube is held near an influence machine which is sparking between its knobs, or in the vicinity of an induction coil whether the latter be sparking or not. If two metal or tinfoil plates about 2ft. square are suspended about 8ft. or 9ft. apart and connected to the terminals of a 5½in. spark coil, a tube 5ft. long and about 2in. in diameter will glow brilliantly when placed anywhere between the plates.

2. By rotating a tube in a constant electric field, thus varying the electric induction through the tube. This effect was recently shown by the writer in conjunction with Mr. Wythe Smith before the Physical Society.

3. By rapidly varying the magnetic induction through the tube, which results in an electric stress at right angles to the magnetic induction. This can be done by wrapping a few turns, or even a single turn, of guttapercha-covered wire round the tube, and discharging a Leyden jar through this wire; a sharp and brilliant luminous discharge will be seen in the tube close to the wire. This discharge can be shown to possess all the magnetic properties of an electric current. The effect is in the main as described above, but is slightly complicated by electrostatic action, particularly in the case where the discharge is feeble, but space will not allow the writer to more than allude to this.

THE SUPREMACY OF NEWCASTLE-ON-TYNE AS A PROVINCIAL CENTRE OF ELECTRICAL INDUSTRY.

BY R. W. WEEKES, WHIT.SCH.

This supremacy may be claimed for three reasons—*i.e.*: 1. The many electrical inventions brought out by the engineers of this town. 2. The number of large manufacturing electrical engineers having their factories in the district. 3. The extensive network of the two supply companies and the low prices charged for current.

It was on October 8, 1880, that Mr. J. W. Swan showed at the Literary and Philosophical Society's rooms at Newcastle-on-Tyne the first incandescent lamps in England. He then lighted the room in which his historical lecture was given by 20 Swan lamps, the current being conveyed about a quarter of a mile from the source of supply. The account Mr. Swan gave in that paper, and in one a few weeks later before the Telegraph Engineers,[*] of the steps by which he had perfected his lamp is a most interesting reading, and shows that Newcastle may rightly be considered as the birthplace of the incandescent lamp. This invention led to the establishment of a large lamp factory in the district, where many of the subsequent improvements in the manufacture of incandescent lamps were discovered.

Several private installations were started soon after this, and Newcastle can claim a large proportion of the first buildings lighted by incandescent lamps. Some of these installations are still at work, and although altered in some details, still show evidence of the skill of the first electric light engineers.

Another prominent invention in lamps also comes from this district—*i.e.*, the Sunbeam lamp, brought out by the Hon. C. A. Parsons. This large candle-power incandescent lamp was first used extensively at the exhibition held in 1887, where it was employed to light all the main courts. It differed from previous lamps in its large candle-power and high efficiency, and thus supplied a valuable addition to the industry. It is a matter of regret that after these lamps had been perfected and manufactured on a large scale to meet the demand, the Sunbeam Lamp Company should have been compelled to cease making them.

Another and, if possible, more important invention by the same gentleman is the Parsons "turbo-generator." This machine appeals more to the engineer than the electrician; but it places at the disposal of the dynamo-builder a generator capable of giving speeds varying from 3,000 to 14,000 revolutions per minute. These speeds allow the construction of much lighter and smaller dynamos than otherwise possible. The steam turbine is a triumph of skilful attention to detail, and the various arrangements for governing, lubricating, etc., are worthy of careful study[†]. The efficiency, determined by careful trials, came out better than was expected. The more recent turbines designed at Mr. Parsons's own works at Heaton give a combined efficiency from steam to electric energy which will compare favourable with many modern reciprocating engines and slow-speed dynamos. The turbines can also be used to drive alternate-current dynamos, and the high speed greatly simplifies the design of the alternator.

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[*] *Proceedings* Inst. Telegraph Engineers, November 14, 1880.

[†] Referred to in issue of *Electrical Engineer*, vol. ix., pp. 34, 63, 86, 110.

Mr. J. H. Holmes, working on less abnormal lines, has done much to aid the advance of electrical engineering. The Castle dynamo, introduced by him in 1886, has stood the test of time and gained an extensive patronage. Mr. Holmes, in 1889, turned his attention to train-lighting, and produced a combination of two dynamos which give constant potential difference with a wide variation of speed. The automatic mechanisms used in this gear to switch the generator on to the lamps when the train starts, and to provide for the various contingencies met with in running, are exceedingly neat.*

There are four large factories in the Newcastle district devoted either wholly or in a large measure to electrical engineering. They are:

Messrs. Clarke, Chapman, and Co., of Gateshead.— This firm still make the first Parsons turbine, but also manufacture slow-speed direct-driven dynamos for shipwork and other purposes. This firm makes a speciality for ship auxiliary engines and gear, and do a large business in ship-lighting.

Messrs. J. H. Holmes and Co. devote themselves solely to direct-current dynamos and accessories. Their factory is admirably designed and fitted out for the manufacture of these machines in large numbers, and they find enough work in this one branch to keep them always busy. Their speciality is shiplighting by slow-speed direct-driven dynamos.

Messrs. C. A. Parsons and Co.—This firm manufacture the recently-designed turbo-generators mentioned above, and have recently completed several important installations, including the central station at Cambridge. They also make transformers and other general electrical apparatus.

Messrs. Ernest Scott and Mountain.—Since Mr. W. C. Mountain joined this engineering firm, their electrical work has become almost more important than their engineering work. They now make two or three types of direct-current dynamos, and also alternators and transformers. Electrical transmission of power for colliery pumping purposes has also received great attention at their hands.

Besides these four large electrical engineering businesses, there are a number of smaller firms in the town and district who, although they do not manufacture on a large scale, do good installation work and deserve the name of electrical engineers. Also several of the large shipbuilding yards keep a staff of electrical engineers.

Turning to the supply companies, the Newcastle Electric Supply Company have the right to supply the northern and eastern parts of the town. The charge made per unit is 4½d., and even with this low figure a dividend is paid. The station was well described in a paper read by Messrs. A. W. Heaviside and R. C. Jackson before the Institution of Electrical Engineers, May 26, 1892. The pressure used is 2,000 volts, and an extensive network of mains has been already laid.

The other parts of the town is in the hands of the Newcastle and District Electric Lighting Company. This company uses the Parsons steam turbine, and the first feature noticed upon inspecting the station is the small engine-room required—the output of the generators per square foot of floor space being about 500 watts. One thousand volts is the normal pressure used, and the charge is 6d. per unit, which affords a dividend. The low prices charged in Newcastle are partly due to the low price of gas and coal, and it is satisfactory to find that with an increased number of lamps connected there is every probability of a reduction in the price, and an ample dividend at the same time.

The street-lighting of Newcastle is at present confined to arc lamps at the principal street corners, but it will doubtless soon be extended throughout the main streets.

On the whole, I consider that Newcastle-on-Tyne has, by subsequent developments, well maintained the lead given to it in 1880 by Mr. J. W. Swan, and is second to no other provincial town in England as a centre of electrical industry.

WHAT IS ELECTRICITY?

BY S. F. WALKER.

The rapid advances that have been made during the past 10 years, both in the practical application of electricity to the service of man and in the knowledge of the principles of the science, have brought us, in the writer's opinion, to the point at which we are obliged to ask ourselves, What is electricity ? if the advance is to continue. Up till very recently, notwithstanding the wonderful guesses that have been made by those not actually engaged either in the study or the practice of electricity, and the closer and closer approximations that have been made by those mathematicians who have given attention to the subject, it may fairly be said that we knew absolutely nothing as to what the mighty force we dealt with was. And, in addition to this, it has not been necessary that we should know what electricity was, so long as we were thoroughly cognisant with what it could be made to do.

Prof. Oliver Lodge first aroused us from this peaceful state when he commenced his crusade against lightning conductors. Those of us who had studied the subject closely felt that Dr. Lodge was wrong, and we believe that in the battle at Bath we successfully defended our position, but it was only by making use of an argument that is always in the mouth of the old type of practical men, and which was therefore dangerously close to the feminine argument—it is because it is. We could not go further because we were lost, literally and metaphorically, immediately we got up in the clouds. What is a charged cloud ? occurred to one again and again, and one was not satisfied with the old stereotyped answer that the cloud formed one plate of a condenser.

Since the battle at Bath, the writer of this article has been closely observing every circumstance that appeared to bear upon the question, and he has devoted a considerable amount of time to the purpose of thinking the matter out step by step, but it was not until after listening to the lecture delivered by Prof. Rücker before the British Association on "Electrical Stress," and after careful thought had enabled him to realise the full force of the experiments so ably conducted on that occasion, that the result, which he now ventures to state, dawned upon him. As far as the writer is able to understand the matter now, electricity is simply motion of the molecules of the different substances which are the subjects of electrical action, just as heat, light, and sound are, and the only difference between these forces is the rate of the motion. The motion of sound, as we all know, is comparatively slow; that of heat and light are very rapid. That of electricity would appear to be somewhat between the slow motion of sound and the rapid motion of the heat-waves, whose motion is slowest. And it would appear that the wonderful adaptability which electricity shows for every kind of work is due entirely to the position which its rate of motion occupies in the scale of the energies. It would also appear that the reason this wonderful agent laid dormant for so many ages, and is even now only partially developed, is very largely, at any rate, because we have no sense which responds to the particular periods of vibration comprised within the electrical range.

As already pointed out, Prof. Rücker's experiments, showing clearly that the dielectric in an electric condenser is compressed by reason of the charge which is present at the surface of the condenser plates, puts the keystone to the arch which is built up of the principles of the science; but once the principle is accepted, it will be found that every known electrical phenomena can be explained by its use, and that many phenomena that have hitherto appeared very puzzling become quite simple when interpreted by its aid. The limits of this article will not allow of illustrations being given, but the writer hopes to return to the subject again, and will then go more fully into details. The writer's reason for referring to the evidence afforded by Prof. Rücker's experiments as so conclusive is because this fact of the increased size or altered form of any body when subject to the strain of one of the other physical forces has always been, and justly so, the grand argument in favour of the principle that these other forces were merely forms of motion within the bodies themselves.

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* *Electrical Engineer*, vol. vii., p. 485.

One of the greatest difficulties, in fact, in approaching a subject of this kind is to train the mind to realise the invisible motion of the molecules of a body in each case. With sound, for instance, we may cause a bell or a tuning-fork to sound their proper notes, yet it is only by the application of special apparatus that we are able to show that these bodies are not only in motion, but actually change their form when emitting sound; so too with heat. It is exceedingly difficult for us to realise that an iron bar is in motion within itself, even when what we call cold, yet it is not difficult to prove that every substance alters its form under the influence of heat, expanding as heat is applied, contracting as heat is taken from it; and that the different states in which bodies exist—the solid, liquid, and gaseous—are due to the different spaces required by the molecules in their vibrations, and therefore to the different rates of their vibrations. As in all these cases it has been shown that change of form, increase or decrease of the lineal dimensions of any body under the influence of sound, heat, or light, can only be due to the increase or decrease of the rate and amplitude of the vibrations of the molecules of the body within itself, so the fact that the dielectric of an electrical condenser is compressed when the condenser is charged can only be due to the increased dimensions of the condenser-plates from the vibrations set up within the plates themselves by reason of what we know as the electrostatic charge. Electric currents, of course, are merely the communication of these motions from one body to another; those bodies such as the metals in which the molecules are more easily able to take up the motion forming what we call conductors, and those which do so with difficulty being insulators.

The writer will conclude this brief notice by remarking that heat currents would be far more efficient than electric currents if we could make use of them as we do the latter, and that, as he before remarked, the reason electricity is such a useful agent appears to be because its rate of vibration is sufficiently high to admit of rapid transmission, yet not sufficiently so to be destructive. It only becomes destructive when it is transformed into heat.

THE SOUTH STAFFORDSHIRE TRAMWAYS.*

BY A. DICKINSON.

Although the president did casually mention to me some days ago that I should be expected to read a paper upon this subject at this meeting, I was under the impression that I had given him sufficiently strong reasons why I should not do so. However, the circular issued by the secretary to the members intensified, if possible, my already strong belief in the saying that there is no rest for the wicked. There are, perhaps, some gentlemen here to whom the technical terms used in the electrical and mechanical sciences would not be comprehensible; I shall, therefore, endeavour to avoid their use, and confine myself to more commonplace phrases, so as to be understood by all.

The South Staffordshire system consists of some 32½ miles of track, partly single and partly double line. It forms a means of communication by road between the important Black Country towns of Bloxwich, Dudley, Darlaston, Walsall, Wednesbury, West Bromwich, and Handsworth, and serves a population of nearly 300,000. A better idea of the importance of the system may be formed from the fact that so far during the present year we have carried upwards of 4,000,000 passengers. The portion of the system which has been electrically equiped comprises about eight miles, and runs from Wednesbury to the Pleck, where it is joined by a line from Darlaston, whence both run to Walsall, where they branch off again, the one going on to Bloxwich, and the other to the boundary of Rushall. These tramways were constructed in 1883-4 under the Walsall and District Tramways Order of 1880, the Walsall and District Tramways Order of 1882, and the South Staffordshire Tramways Extension Order of 1882, and were opened for public traffic in September, 1884. The cars have up to now been propelled by steam locomotives of the Wilkinson type. The Board of Trade granted a license for the use of steam for seven years, and this having expired in 1891, the company made application for an extension of a further period of seven years. This was refused, but the Board of Trade granted a temporary license until March, 1893, but the local authorities declined to consent to its use beyond December, 1892, and as their sanction is rendered necessary by the wording of the provisional orders, we are debarred from using steam from this date. The directors, therefore, had to consider the adoption of some other means of traction to replace steam. It will be evident to most of you when you refer to the plans and sections upon the backs of your invitation cards for the opening ceremony that to work such a tortuous and heavily-graded line by means of horse traction would be almost an impossibility, and as it is mostly single line with turnouts, the cost of equipping it and the difficulties of working with cable haulage would be so increased as to render it practically prohibitive. The three most practical systems of hauling tramway cars at present in vogue in this country having thus been disposed of, the directors had only the different methods of electrical traction to consider—namely, accumulator, conduit, and the overhead wire. Of the two former there is little to be said, as neither has as yet been practically demonstrated to be perfectly satisfactory. Of the latter there is only one instance where it is at work in this country—namely, at Leeds, where what is known as the span-wire system is used. This is a line engineered and built by Americans. The rapid development of overhead traction in America caused the directors to turn their attention to this system. Although there were many objections raised, owing to the number of wires it necessitated being carried across the roads, the directors instructed me to visit the United States of America and inspect the various systems in use in that country. This I did, and I returned to England fully convinced of the utility of the overhead wire; but I could see that the objections made to it by the local authorities, on account of its unsightliness, would fall to the ground providing it could be used without the span-wires. To accomplish this object I devised the arrangements which I will now proceed to describe.

I will commence with the generating station, which is the heart of the system. It is a substantial building, which does not boast of much ornamentation, and comprises engine-house, boiler-house, stores, etc. It is situated upon the Walsall-road, at the Pleck, which is about the centre of the lines. The canal runs close beside it, and an arm has been cut alongside the boiler-house, so that we can, if necessary, unload our fuel from boats right into the fire-holes.

In the boiler-house are fixed three boilers of the Lancashire type, each being 30ft. long and 7ft. diameter. They are tested by hydraulic pressure up to 200lb. per square inch, although it is only proposed to work them at a pressure of 120lb. The engine-house contains three compound condensing engines, each of 125 i.h.p., at 100lb. pressure and 100 revolutions per minute. The high-pressure cylinder is 16½in. diameter and the low-pressure 20in., and they have a stroke of 30in. Each engine is fitted with a surface condenser and a 4½in. diameter air-pump, with a 30in. stroke, the same as the engines. Canal water is used for condensing. Each condenser is supplied by a centrifugal pump, driven by belting off the main shaft of each engine. The driving-pulleys upon the engines are 10ft. diameter, and are each grooved to receive nine 1½in. diameter ropes; these in turn drive the 2ft. diameter pulleys upon the dynamos. This system of driving was adopted in preference to belting owing to the increased factors of safety obtained, as it is possible to continue working with several of the ropes broken. There are three dynamos of the Elwell-Parker type. They are shunt wound and have drum armatures, and each give at 450 revolutions 250 amperes at a pressure of 350 volts. The armature shafts are in two pieces, being joined together by a coupling between the armature and the pulley. The advantage of this is that in case anything goes wrong with the former, it can be taken out of its place and replaced without disturbing the driving ropes. For machinery of this description, with almost continuous running, the lubricating arrangements require to be very effective. Sight-feed lubricators are used upon the cylinders, and a continuous flow of oil is kept upon the main shaft bearings by means of a small centrifugal pump driven by cords from the shafts. Upon the dynamo there is a special and most ingenious arrangement, the patent of the Electric Construction Corporation. On the shaft in the centre of each bearing is formed an eccentric, over which is placed a small ram-pump. The upward motion of the plunger is given by the eccentric and the downward motion by a spring on the top of the plunger. The oil both from the engine and dynamo bearings flows back through a filter to the oil-well from which it was drawn by the pumps. Special arrangements are also made for oiling crank bearings, slide-blocks, and other parts of the machinery.

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* Paper read before a meeting of the Tramways Institute at Birmingham.

The switchboard is placed at the end of the engine-house nearest to the road, and upon it are fixed ammeter, voltmeter, and resistance coils, and an automatic magnet cut-out switch for each dynamo. This switch is so arranged that when there is a flow of current in excess of the capacity of the installation it is automatically thrown out, thus breaking the circuit and reducing the risk of damage to the dynamo to a minimum. The whole of the buildings are lighted by means of incandescent lamps.

A feeder-cable is laid out from the switchboard at the generating station underground to the roadway, whence it is run along the outside edge of the channelling, some 15in. below the surface of the roadway, so as to feed in to the trolley wire near to the heaviest points upon the road, and thus equalise the pressure of current in the wire. The connections are made to the trolley wire every half-mile by means of a branch distribution-box. From this box two other cables are carried up the inside of the pole and along the arm which supports the trolley wire, and are connected to the line-breakers, which divide the trolley wire up into half-mile sections. Between the cable which comes off the main feeder into the fuse-box and those which run up the pole there are two fuses. These are so arranged that in case of any short circuit or earth being made by any section of trolley wire, as would probably be the case if the wire broke, the fuse burns out and disconnects the length of wire. The trolley wire is solid hard-drawn copper of 0 B.W.G. It is riveted by means of copper clips to insulators which are suspended from the arms of the poles by steel clips and pins 21ft. above the track. At turnouts or points where a branch wire is led off from the main wire, specially-constructed brass switches with spring tongues are used, which in the case of turnouts guide the trolley along the left-hand wire, when it passes in the one direction, and which opens to let the trolley through, and automatically closes again when it passes in the other direction. In the case of switches which work in connection with movable points for branch lines or depôts, there is an arrangement of cords and pulleys by means of which the conductor of a car can simply pull them over when they are required to be used, otherwise a spring holds them clear of the main wire, giving the trolley a free passage along it.

The poles which carry the trolley wire form an important part of this installation. My aim was to design one that would give a maximum amount of strength with a minimum weight, and which would present a fairly elegant appearance. I attained this by having them made of mild rolled steel and tapered for 18ft. of their length. Each pole is composed of two tubes, a parallel and a tapered one, the latter being shrunk into the former. They are 30ft. long over all. There is a buckled steel base-plate, 2ft. square, bolted to the base of each, upon which rests the concrete foundation, which extends 6ft. into the ground. There are three sizes of poles, those for ordinary single line being 6in. outside diameter at the base and tapering to 2¾in. at the top, and having arms varying from 2ft. 6in. to 6ft. 6in. in length. Those for double line, or for where the rails are an exceptional distance from the footpath, are 7in. outside diameter at the base and taper to 3¾in. at the top, and have arms varying from 7ft. to 13ft. in length. The arms for these two classes of poles are of different diameter, the short ones tapering from 2⅜in. to 1½in., and the longer ones from 2¾in. to 1½in. diameter. In special cases, where there are awkward corners or an exceptional strain upon the wire, and consequently upon the poles, I have had extra strong ones fixed: these are 12in. at the base and taper to 5in. at the top, and are made throughout of ½in. mild rolled steel. There are two cast-iron grid frames bolted to the pole, one at the base and the other 5ft. higher up, and the intervening space is filled up with concrete, thus forming practically one solid block with the pole. In most cases these poles are fixed in positions originally occupied by lamp columns at the junction of the roads, and owing to this we had to fit them with lamps and gasfittings complete to replace those removed. I must not conclude my description of these poles without saying that great credit is due to Mr. Johnson, of Messrs. James Russell and Sons, of the Crown Tube Works, Wednesbury, who manufactured them, for the very great interest he took in the work. In fact, the making of these 12in. taper poles, even in this advanced age of tube-making, may be regarded as a feat of no mean order.

The 16 cars are built to a 3ft. 6in. gauge, and have fixed wheel bases of 6ft., the wheels being 33in. diameter, and specially made with rolled-steel tyres upon cast-steel centres. They will seat 40 passengers—22 inside and 18 outside. All the seats are of the garden type, with reversible backs. The motor trucks are specially made of pressed steel, and support the car body upon eight spiral springs. There are two 15-b.h.p. single-reduction motors upon each car, one coupled to each axle by means of steel helical gearing wheels running in oil in a dustproof case. There are two pairs of carbon brushes running upon the commutator of each motor. They are accessible from the inside of the cars by means of traps in the floor. Each car is fitted with an ordinary quick-action brake, and also with an entirely independent emergency brake, both of which are operated from either platform of the car, thus giving the conductor an equal chance with the driver of stopping the car in case of danger. The switch-boxes on the platforms of the cars each contain a lightning arrester, a controlling switch, a reversing switch, and a motor switch, the latter being for the purpose of changing the motor or using both together. There are also the necessary fuses and resistance coils. The portion of the car which it is perhaps most difficult to explain lucidly is the trolley or collector. It has to make an uninterrupted bridge or connection through the constantly varying space between the car and the trolley wire. This necessitates a vertical and a horizontal movement, which I found could be obtained by combining a radial movement in a telescopic trolley-stand with a hinge or bellcrank movement on the trolley-mast itself. This arrangement, in fact, forms what the trolley practically has—viz., a universal movement.

The trolley-mast is 13ft. long, and is made of very light taper steel tube, with the trolley-fork at the small end and the bell-crank at the larger end. This latter is pivoted in a jaw upon the trolley-stand. The trolley wheel is kept up against the wire by means of six coil springs pulling the short arm of the crank down towards a saddle upon the trolley-stand to which they are connected. The trolley itself is a small brass wheel, with flanges very similar to a rope pulley, and runs in a wrought-steel frame with guards upon either side. The frame terminates at its base in a spindle, which drops into a vertical bearing upon the end of the trolley-mast. This gives the wheel and frame a free radial movement to adjust itself to the wire, apart from any horizontal movement of the trolley-mast. In other words, the trolley-stand forms the centre from which the trolley itself can in its movement upon the wire describe a circle of 26ft. in diameter. The whole of the joints of the rails are bonded to facilitate the passage of the return current back through them to the dynamos. This is accomplished by drilling holes in the ends of the rails, which are afterwards plugged with wrought-iron plugs, which are connected together by copper wire; in addition to which there is a cast-iron sole and fishplate attached to each joint, and earthplates at frequent intervals along the road. I can, perhaps, make the whole arrangement more lucid by describing a car in actual work. First, the current is generated in the dynamos by the engines, and thence it goes through the switchboard to the feeder, and from the feeder up the cables before described to the line-breakers, and so into the trolley wire, down the trolley mast and stand, through the switch and resistance coils, and to the car motors. Here it does its work in propelling the car, and then passes through the axles and wheels to the rails and along them back to the dynamos at the generating station.

There was a strong prejudice existing in the minds of the public that this system was exceptionally dangerous to life, and there is no doubt that to a certain extent it still remains; but the fact that there are over 8,000 motors in daily work in American cities, and that as yet there has not been a single fatal accident owing to persons coming in contact with the wires, should do much to remove it. The pressure used in America is 500 volts, and we only use 300; therefore, so far as safety is concerned, we have a greater factor than they have. This popular belief evidently existed in the minds of some gentlemen who came here and inspected this system as a deputation from the Coventry Town Council a few weeks ago, when, in explaining some part of the mechanism, I accidentally got into the circuit myself, and gave them quite a surprise by remaining alive. However, after some persuasion, I got them to take the current, and even they had life enough left in them to go to the George Hotel, Walsall, and eat a good tea.

The whole of the work has been installed by the Electric Construction Corporation, of Wolverhampton. The directors placed this contract in their hands because, from their great experience, they deemed them the most fit contractors for the work Mr. Thomas Parker, their general manager, has taken great interest in and devoted a considerable amount of attention to this system, and Mr. E. T. Parker, son of Mr. Thomas Parker, has been resident engineer on the work.

The South Staffordshire Electric Tramway, as above described, was formally opened on Saturday, December 31st. A number of the members of the Tramways Institute and a large number of guests attended the ceremony and trial run. We have in our issue of November 18th, 1892, so fully described this line, that further reference is unnecessary.

ELECTRIC LIGHTING OF S.S. "TCHIHATCHOFF."

The above vessel recently built by Messrs. Denny and Brothers, of Dumbarton, for the Russian Steam Navigation Company, Limited, was fitted throughout in a most complete manner by Messrs. J. H. Holmes and Co., the installation being carried out on the Holmes improved single-wire system, and to meet the requirements of Lloyds.

On the top platform of the engine-room two electric generating plants are placed, each consisting of a combined engine and dynamo mounted on one bed-plate, each dynamo being coupled direct to the crankshaft of its engine. The engines are of the open type, compound, each fitted with double cranks and automatic expansion flywheel governor acting directly on the slide valve. The dynamos are of the Castle type, and are each capable of supplying current for 200 16-c.p. lamps when running at a speed of 250 revolutions per minute. From the dynamo terminals the main cables are taken to the main switchboard, which consists of an enamelled slate slab encased in a polished mahogany frame fitted with seven 50-ampere switches and fuses, also two ammeters and one voltmeter. The main switchboard is so arranged that all lights can be run off one machine or any particular circuit on either machine. Each switch is provided with an ivory tablet, on which the name of the circuit it controls is engraved. These are "Second Class," "Engineers," "Engine-room," "Saloon," "Staterooms," "Forward," and "Emigrants." Lead-covered cables are laid from the main switchboard to auxiliary switchboards, which are placed in convenient positions with switches and fuses, each of which controls a branch circuit of eight or ten lights. No branches are taken from the main cables, except at the auxiliary boards. The distributing-boards for saloon, stateroom, and emigrants are fixed in first-class pantry, and each consists of an enamelled slate slab carrying the necessary switches and fuses. Each switch here has an ivory tablet fixed underneath, indicating the lights which it controls. These boards are fitted with neat mahogany frame and glass front, with lock and key. From these boards stranded conductors are led to the various groups of lights.

All the wires are laid in wood casing to match the different woods throughout the ship, the covers being screwed on with round-headed brass screws. The wires are insulated in a special manner with vulcanised indiarubber, then braided and compounded; the insulation resistance being 2,000 megohms per mile; each coil is tested in water after being immersed at least 24 hours. The fittings are of brass, and are of Messrs. J. H. Holmes and Co.'s own special design and make. Those in saloon and first-class accommodation are of the best Elkington electroplate. For the engine-room lights, the cable is laid from the "engine-room" switch on the main switchboard to an auxiliary switchboard on the top platform. On the latter are placed switches, with polished brass covers, labelled respectively "Top Platform," "Middle Platform," "Starting Platform," "Forward Stokehold," "Aft Stokehold," and "Tunnel." From these switches wires are laid to the various platforms, etc, as indicated by the tablets, branches being taken to the individual lights. By this method of distribution the lights are under the control of the engineer on watch, and he can light up any portion of the engine-room and stokehold without leaving the electric-engine space. All the wires in the engine-room, stokehold, tunnel, and galley are, besides being insulated in the ordinary manner, further protected by a lead sheathing, and also a galvanised-iron sheathing, and again braided over all. They are not cased in so as to be difficult of access, but fixed to the bulkhead by brass clips, and, therefore, can be easily traced out, and also give very neat appearance to the wires. No soldered joints are made in the engine-room, all connections being made mechanically in cast-metal boxes, the latter being made watertight. By this means the system is reduced to its simplest form, and any sea-going engineer can make a joint of this description. All fittings in the engine-room are of Messrs. J. H. Holmes and Co.'s special design and make, every part being interchangeable. There are four cargo lanterns, each containing eight 16-c.p. lamps connected to a convenient length of armoured flexible cable, also eight portable hand-lamps for deck use in embarking or disembarking passengers. These lamps can also be used in the holds. The masthead and side lights each contain a double-filament lamp of 32 c.p., and are controlled by switches placed in the wheelhouse. Altogether there are 270 lights installed throughout the ship.

CORRESPONDENCE.

MULTIPHASE TRANSMISSION OF POWER.

SIR,—I am very much surprised to learn that Mr. B. H. Thwaite is not aware of the share taken by the Allgemeine Elektricitäts Gesellschaft, considering the name of this firm has been prominently mentioned in all *bonâ fide* and correct descriptions of the Frankfort-Lauffen transmission plant.

Not only were nearly all the original designs of generators, motors, and transformers prepared in accordance with the patents of Mr. Dolivo von Dobrowolsky, the head engineer of the Allgemeine Elektricitäts Gesellschaft, but important portions of the plant were made at Berlin, and a large proportion of the expenses of the Lauffen-Frankfort plant was borne by the above-mentioned firm, who I may add own a series of patents relating to this successful system of electric transmission of energy.

I have no desire to detract from the honour due to the Oerlikon Works, where the generator was manufactured, nor from Mr. C. E. L. Brown, who worked in conjunction with Mr. Dolivo von Dobrowolsky, to the final good and success of this gigantic enterprise, but I am desirous that the historical facts should not be altered.

In all probability the Allgemeine Elektricitäts Gesellschaft, whose sole agents we are for Great Britain, will fully reply to Mr. Thwaites's letter.—Yours, etc.,

F. T. EGGERS, General Manager.
Electrical Company, Charing Cross-road, W.C., Jan. 5.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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1892 PAST—1893 PRESENT.

TO ALL READERS A HAPPY AND PROSPEROUS YEAR.

Young England, and, in fact, old England, is interested in the development of the electrical industry, for both Englands combined seem to think the profession a future El Dorado. Young England is therefore being pitchforked into electrical work in considerable numbers, so that soon the question of room and overcrowding will become prominent. What are the prospects for young men desirous ot making a position and earning a good salary? We should say, not over bright. Consider for a moment the work to be done, commencing with the lowest round of the ladder. Wiremen approximate to unskilled labour, and the young men about whom we write are not of the class to become wiremen. A somewhat similar but rougher class are found in the navvies who are employed breaking up the streets and laying mains. Closely connected with these operations, and working side by side with the above-named, are the "jointers." Now, a thoroughly trustworthy jointer ought always to command good wages. He comes in as a skilled workman, and upon his care the success of an installation very largely depends. In the central stations we find both skilled and unskilled labour; but it is not till we reach the more responsible men in the stations that we reach those ranks likely to be recruited from the well-to-do young England. The men who are to take charge of central stations should, in the first place, be trained engineers as well as electrical engineers. They should serve an apprenticeship, and go through the shops. This will cost their parents considerable sums of money, and in return they expect a fair salary. We do not know that *good* men need fear about getting adequate return. They are worth their salary—and a good salary, too—for the future of the central station is in their hands. They must not only be competent mechanical and electrical engineers, but be also men of the world, and able to manage men. Higher still in the scale we come to the consulting engineers, about whom we shall write further on. Here we come to the designer, the best paid, or the one who should be the best paid, of all. He puts the apparatus into the hands of the central-station engineer, and if the latter is to make a success this apparatus should be as perfect as possible. In the ranks we have also to deal with skilled and unskilled labour. The skilled artisans are recruited in the ordinary way, and it is not till we come to the designing and management that high salaries are asked and given. There is another field to be filled, that of electrical engineer to local authorities. This position will, we imagine, constitute one of the prizes in the profession, and the occupier must have much of the ability of the consulting engineer and the engineer-in-charge combined. Many young men, however, desire to obtain an acquaintance with things electrical in order to commence business for themselves. This brief review of the directions in which educated work is required, and the prospects of a good income will show that while the field is large it is not unlimited. The salaries paid will not be extravagantly high, but approximate to those paid in other engineering work. Municipal electrical engineers may expect from two to five hundred pounds a year—the latter not just yet. The consulting engineer, like the barrister, may sit biting his fingers for years before getting an income. He must fight his way in Great George-street like his brother civil and mechanical engineer. The largest class will be engineers connected with central stations, and their salaries can, at the present stage of affairs, hardly be determined.

Consulting Engineers.—With the continued advance of electrical work, especially in the directions of lighting, traction, and transmission of power, the consulting engineer becomes more of a necessity, and also becomes a greater power in the land. It is extremely difficult to define the qualifications of a first-rate consulting engineer—they are not to be gauged by examinations, but, like political genius, must be born in the man. A modicum of the qualifications may be acquired by experience or from good teachers, but unless the man is born to it, he never takes a position in the front ranks. In the early days of new professional work the charges of the professional man are regulated by nothing. There is no appeal to custom. Each man has to speak for himself. This has been the case with consulting electrical engineers, but the time is rapidly approaching, even if it has not come, when some common method of charging should be recognised. It seems to us that electrical engineering is but another specialisation of mechanical engineering, and that the consulting engineer's charges, whether for the mechanical or electrical branch, should conform to the charges recognised in mechanical consulting work. Employers, however, may rest assured that the most expensive consulting engineer is seldom the dearest. He is able to put a high value upon his services because those services are real and not nominal. He usually brings about considerable saving in the work to be carried out, because his knowledge of the subject and his experience are greater than the knowledge and experience of those who rate the value of their services at a somewhat lower figure. The aim of the consulting engineer should, as we have pointed out before, be perfection of design and specification; leaving nothing to chance or the whim of contractors, but a thorough combination of details, each one of which has been thought out and examined in connection with the position it is intended to occupy in the whole scheme.

Companies' Difficulties.—The year 1892 ended somewhat gloomily for several companies, in that at the general meetings held then the balance-sheets were altogether unsatisfactory. It may be said that in all cases the difficulties had long been apparent, and no one given to the examination of companies' affairs was surprised. The most difficult thing to understand is that the men who have led the companies into the sloughs generally get off scot-free; indeed, in many cases, manage to appear as being hardly used. Messrs. Poole and White are in liquidation, therefore in this case nothing can be said to damage the concern. Messrs. Woodhouse and Rawson, after a peculiar career, are in almost inextricable difficulties. The concern will need a straight head and strong hand to pull it through. Given the man, we should not despair; but where is the man? No doubt the committee of investigation will have something to say in the matter, meanwhile the only thing possible for shareholders is to "hope on." They have undoubtedly the nucleus of a very fine business, and if the same attention had been given to the trading part of the concern as has been given to "make money rapidly and in the lump," the company would not be in difficulties. The Electric Construction is on different yet firmer ground. According to information given, its books and affairs have been carefully overhauled by competent authority, which, after such examination, agreed to find one-half of the further money required. These are three typical cases. The first exemplifies the flying at too high game, and failing to obtain the required work. Premises, machinery, and a large staff rapidly eat away capital unless sufficient orders are forthcoming. The second case exemplifies the dangers of speculation. Someone was injudicious enough to point out that the shareholders had two years in succession 15 per cent. dividends. That, to use an expression we indulge in, was pure unmitigated misrepresentation. The original shareholders have had two such dividends, the people who put their money in after one year's working have had one dividend, those who put it in last year have the consolation of paying but not receiving. Put it another way: the man who invested £100 three years ago has got back £30, the man who invested £100 two years ago has got back £15, while the man who invested his £100 last year gets no satisfaction except the perusal of a balance-sheet which on the face of it shows a loss of more than £2,500 a week during the year. A more careful examination might lead us to find that the original shareholders largely got rid of their shares while dividends were flying around, while later investors are "left." The third case is one of peculiar hardship—one in which sufficient working capital was not left after the matter was out of the hands of the promoters. The workers in such a case are heavily handicapped. They see the possibilities and feel the restrictions. They also too frequently have to bear the brunt of all the troubles brought about by no fault of their own. We trust that with the new capital an era of greater prosperity will commence. The reference to the difficulties of companies bring us to consider a grave blot in electrical matters connected with

Technical Papers.—There is a lying spirit abroad, and we are sorry to see technical literature so disgraced as it is at the present moment. Politicians and religious communities find it convenient to run their own organs, so that their views may be faithfully promulgated and those of their opponents satisfactorily criticised. It has been left to technical journalism—to the electrical era—for company-mongers and wire-pullers of companies to obtain control of special organs. The technical journals so controlled are run for no worthy object. They are intended to mislead the multitudes who are ignorant of the behind-the-scenes. They pretend to the highest respectability, and at the same time are carefully abstaining from obtaining or telling the truth in directions which in every case it would not be difficult to indicate. Not speaking is ofttimes worse than too much speaking. These journals are not intended to benefit the trade generally after benefiting the proprietors specially: they are intended to benefit a portion of the trade by the active propaganda of biassed opinions, and to injure the remainder of the trade by the suppression of what might with advantage be told. Let us see how it is possible for one of these controlled journals to act. Information from outsiders is naturally sent to newspaper offices. Such information is presumably for the benefit of the whole trade, and is supposed not to be divulged except in the pages of the paper. In the cases we refer to, can anyone acquainted with the facts doubt but that it is divulged to interested parties, who may thus be given some clear days to "work the oracle"? Further, by the undue prominence given to the work of the controlling companies, and the issue of copies broadcast to municipal authorities, and by judicious "press" opinions, votes or important information may be obtained. Articles are written in these papers, not for the purpose of telling the truth, but solely with the object of influencing opinions in certain directions. The general public, who can for a time, and for a time only, be influenced by these pernicious measures, is to be pitied. Some are induced to entrust work in directions in which, if the truth was known to them, it would not go. But not only is damage done in these directions, but the investing public is hoodwinked. Prospectuses are sent forth broadcast containing extracts from articles from these tainted sources, and investors are by these means induced to find capital that ought not to be furnished, and large parts of which go directly into the hands of the company-mongering promoters. It is extremely difficult to distinguish between the good and the bad in company work. There is, however, one method which, if followed, means probable loss to the company and undue gain to the promoters. It is when the real movers are ashamed to act for themselves, and put up nonentities who nominally make the contracts and take the spoil, but who are in reality only nominees of those behind the scenes. What have the shareholders, for example, to say in connection with the formation and working of the "Metropolitan Electric Supply Company"? Has it ever been satisfactorily explained who got the promotion-money, and why with such a flourish of trumpets this company's shares are now quoted far lower than they were 12 months ago? Were the quotations of 12 months back engineered so as to allow parties to unload, and as soon as the unloading was finished did the quotations commence to and continue to fall? As far as real work is concerned, is not the company to-day in a better position than it was 12 months since, and yet the capital depreciation is enormous. There is good reason for watching the progress of this company. The annual meeting was held last May, the quotations then were 8⅝, now the quotations are down to 6¾. Glowing prospects were held out to the shareholders at the meeting, and many are anxious to know why this depreciation of their property? Has the technical journal controlled by the men who are, or were, high in power in this company ever favoured the public with an adequate explanation of these financial matters? Yet financial difficulties are very real in electrical work, and everything possible should be done to give investors a firm belief in paying capabilities for electrical work, when carried out honestly and faithfully. You cannot get this independent criticism from papers which are run by company promoters, directors, managers, and financial agents.

BUSINESS DURING THE PAST YEAR.—As usual we have collected a number of reports from various firms which give a fair idea of the electrical business in 1892. No doubt further reports will come to hand during the next few days, and these will be given in a future issue.

G. E. BELLISS AND CO.—This firm have been very busy during the year with their open vertical compound high-speed engines for direct driving. These engines are of their well-known central-valve type, running at about 300 revolutions per minute, and are designed specially for constant running at this speed. During the year this type of engine has been supplied, amongst others, for the new Cunard steamships "Campania" and "Lucania," for the Royal Mail Steamship Company, British Museum, Preston and Carlow central stations, and large numbers to the Admiralty, to the India Office, and War Office. The firm are now also busy with their closed-in engines of the central-valve and other types designed for constant running at a still higher speed. One of these is driving the dynamo for the electric light in use at the firm's premises in Ledsam-street, and has been constantly at work throughout the year with the most satisfactory results. The largest of this type at present supplied developes 300 i.h.p., and is used by Messrs. Siemens Bros. and Co. at their central station at Charlton. The firm have also in hand a considerable number for the new torpedo vessels building by the Admiralty and others. These engines being ordinary simple double-acting engines, closed in so as to permit of a large supply of oil under pressure to all the bearings, have nothing about them which is likely to cause trouble, whilst the value of the casing in protecting the machinery from dirt, and enabling thoroughly efficient lubrication, is very great.

BRUSH COMPANY.—The Brush Electrical Engineering Company report that during the past year most of the departments of their extensive works have been kept fully employed. Contracts for central station works, for which the factories and organisation of the company generally are specially equipped, have naturally preponderated. Very considerable progress has been made with the installation at Bankside for the City of London Electric Lighting Company, and the Brush Company are at present engaged in erecting additional sets of large generating plant, which will enable the City Company to get abreast of the urgent demands upon them for light. The work in connection with the station for the Huddersfield Corporation has been delayed in consequence of a strike, which hindered the progress of the station buildings, but this difficulty has now been overcome, and the works are being rapidly pushed forward. Among the other important central station contracts secured during the past year are those for the Corporation stations at Worcester and Hanley, and additional plant has been supplied for extensions at the Newcastle, Sheffield, Bournemouth, Chatham and Rochester, Hastings, Exeter, and Shanghai central stations, while orders have been received for plant for new installations at Prescot, Windermere, Killarney, Port Louis, and a number of small towns on the Continent and in the Colonies generally. Brush arc plant has been supplied to the Corporations of Dublin and Glasgow for street-lighting, and the Hanley contract included similar plant for the same purpose. The Brush Company's contracts for exhibition lighting during the past year include the lighting of the exhibition at Douglas, and the supply of the whole of the electrical plant which was used for the lighting of the International Horticultural Exhibition at Earl's Court. Amongst the large number of isolated installations secured by the company during the year, the most notable are those for Arundel Castle, the seat of his Grace the Duke of Norfolk; Southill Park, the country residence of Sir Arthur Hayter; Wotley Abbey, P. Hardman, Esq.; Letham Grange, Major Neale; the Bilston Market Hall, the Douglas Grand Hotel, the Nottingham University College, the Nottingham Castle Museum, the Lyceum Theatre, Sydney; arc lighting plant for the Caledonian Railway Company's Princes-street Station, Edinburgh; the London, Brighton, and South Coast Railway Company's station at Victoria, and for a large extension at the works of the Consett Iron Company at Durham, etc. A large number of direct-coupled engines and dynamo machines for installation on shipboard have been supplied to various Governments and to shipbuilders, while the installation work on shipboard completed by the company during the year includes the lighting of H.M. ships "Sappho" and "Scylla," built by Messrs. Samuda Bros.; two cruisers for the Argentine Government, built by Messrs. Laird Bros.; a large steamer for the Austrian Lloyd Company, constructed by Messrs. J. L. Thompson and Sons, etc. Although the general depression of trade has made itself felt in the rolling stock departments of the company's manufacturing business, important orders have nevertheless been received and executed, among which may be mentioned locomotives and rolling-stock for the new Beira Railway, and for the Bangkok Railway, Siam. The company have also supplied cars for electric and other traction. Considerable improvements have been made in the construction of plant adapted for railway train-lighting, and orders have been received for a number of new machines for train-lighting on the London, Brighton, and South Coast Railway system, the Adelaide Government Railways, and elsewhere. The company have also carried out some important contracts for electrical power transmission plant, both in this country and abroad, during the year. The company took a prominent part in the electrical exhibition which was held at the Crystal Palace in the early part of the year, and their magnificent show of moving and stationary machinery and other specimens of their manufacture attracted a great deal of attention. By legal proceedings in the New South Wales Courts the Brush Company have established the validity of the Edison master incandescent lamp patent, of which they are the owners in the Australasian colonies, India, the Cape of Good Hope, and Natal, the defendants in the action referred to being condemned to pay costs and damages in full. The company require that all orders for lamps for use in those countries where they hold the patent shall be sent to them or to their Sydney branch, 56, Margaret-street, Wynward-square, Sydney, for execution. It would not be right to close this short review of the Brush Company's operations during the past year without referring to the loss the company has sustained by the sudden death of the chairman, the late Duke of Marlborough. The death of the duke has been severely felt, not only by the Brush Company, but by the electrical industry generally, his interest and activity in all matters affecting the welfare of the industry being well known. Mr. J. B. Braithwaite, who has been a director of the company for many years, has succeeded the late Duke of Marlborough as chairman.

Crompton-Howell Electrical Storage Company.—If in these busy days memory can be trusted to go back for 12 months, it will be remembered that in our *résumé* of annual work we were enabled last year to tabulate the work done by the Crompton-Howell accumulators at the central station at Kensington Court. This was, perhaps, the first authoritative information that had been published as to the working of this type of battery. During the year there has been a very fair demand for the Crompton-Howell cells, as will be seen in the following brief summary of the most important works the firm have undertaken:

McGill University, Montreal ...	120	cells capable of discharging	at amps. each	200
Glasgow Corporation.....	120	,,	,,	600
Hull Corporation	120	,,	,,	300
Central lighting station, Oporto	60	,,	,,	300
Hove Electric Lighting Co.......	118	,,	,,	200
Blenheim Palace........	104	,,	,,	200
J. C. Howell	54	,,	,,	200
Oldham Corporation	67	,,	,,	300
Crompton S. C., Australia	50	,,	,,	300
Edison Co., New York	120	,,	,,	500
Pretoria Co.	144	,,	,,	600
J. C. Howell...........	120	,,	,,	600

In addition they have supplied to the customers given below over 1,000 cells of various sizes, which it would be beyond the scope of this brief summary to recapitulate in detail. In confirmation of what was said about these batteries last year, the company has been extremely fortunate during the year just ended, in having no trouble with regard to renewals or repairs of their batteries. The customers supplied are Fowler, Lancaster, and Co.; Chamberlain and Hookham; Crompton and Co., Limited; Beavor Webb; J. C. Howell; Lloyd and Lloyd; — Hicks, Esq.; Interior Conduit Company, New York; Ferranti and Co., Limited; Prof. Carey Foster; Western Counties Electric Lighting Company; Laurence, Scott, and Co.; Prof. O. Lodge; H.M. Dockyard.

Dorman and Smith.—This firm states that the result of the first year's working in their new factory has more than justified the decision they came to in 1891, to remove the business into larger premises, and commence manufacturing on a much more extended scale than heretofore. Judging by the nature of the year's output, it has apparently been one rather of preparation for the future than of actual completion. Even with increased facilities, their heavy department for main switches, switchboards, etc., has been overtaxed, and the men kept on overtime a great part of the year; the distributing arrangements put in by contractors being generally capable of controlling large extensions of the installations. In smaller gear, such as small switches, fuses, fittings, etc., while there has not been such a marked increase in the orders given out by the leading contracting houses, the amount of material used by the smaller wiring firms, and the enormous increase in the number of the latter during the year, shows that there is a tendency, especially in the provinces, to employ local men for wiring contracts. Orders for shipment have increased satisfactorily. Firms engaged on ship-lighting have apparently not been quite as busy as usual, especially towards the close of the year. The large number of central stations now in progress up and down the country are gradually but surely increasing the proportion of goods used in the provinces, and it is in this direction, rather than in London, that the firm looks for great extension of output during the coming year. Messrs. Dorman and Smith are very pleased to record the fact that there is a distinct general tendency to use better material, and that they do not now feel the unhealthy competition of cheap English and foreign rubbish at all.

Drake and Gorham.—The contracts carried out by this firm during 1892 we find reach a total of nearly a hundred, or about two per week for the whole period, and the number of lights installed by them during the past 12 months is over 10,000. A large proportion of these installations are contracts obtained for country-house plants, and the amount of work thus entrusted to them during the year should be very gratifying. Still further improvements have been made in the D.P. battery, which, having been put down at a large number of installations, is now out of the experimental stage, and contractors are using them very extensively. Reports of these cells say that they are very durable, and will stand harder work than any other type in the market. The Cardew instruments, the patents of which Messrs. Drake and Gorham are the owners, command, as formerly, a ready sale, a large number of them having been sent out during the past year. It will be remembered that they lately brought out, in conjunction with Captain Holden, new recording instruments. A number of these have already been supplied, although having been on the market for so short a time, and are reported to be giving every satisfaction. In connection with the electric light installation at Callaly Castle which they have just completed, Messrs. Drake and Gorham are installing an electric lift for passenger and luggage purposes, which will be driven by a 6-h.p. motor. The hoists previously put down by the firm some years back are still giving great satisfaction. The patent electrostatic indicator introduced by the firm to comply with the requirements of the Board of Trade has been considerably improved, and with this instrument the insulation resistance of either of the high-tension mains can be seen at any time. The price is low, and high-tension companies will no doubt use it extensively. Several petroleum engines have been installed, both of Priestman's and Crossley's make. Two of the former have been put down in connection with the installation at Chalfont Park, Slough. They are working satisfactorily, and will no doubt be in greater demand during the ensuing year.

Electric Construction Corporation.—This company has supplied the whole of the plant for the Oxford Electric Light Company, including buildings, generating plant, high-tension cables, transformers, and low-tension distributing mains. This station is the first working on the high-tension continuous-current system with motor-generators, the latter being controlled entirely by the man in charge of the switchboard. We have already given a somewhat extended notice of this station in our issue of June. During the year the company has supplied alternating-current machines for the Dublin Corporation's station, Johannesburg, and extensions to the House-to-House Company's station, West Brompton; Brighton Electric Light Company; and now have in hand machines for the Leeds Electric Light Company, Coatbridge, etc. Continuous-current machines have been supplied to the Liverpool Electric Supply Company, etc. During the year a complete contract has been carried out for equipment of about seven miles of line, in South Staffordshire, on the overhead trolley system. Six cars are supplied, and, as our readers will see elsewhere, actual service commenced on January 1st. The company is just now completing a contract, which has been in hand during the greater part of the year, for the electrical equipment of the overhead railway in Liverpool. Generating plant for 1,800 h.p. has been installed. Length of line is six miles, and will be provided, in the first instance, with 15 trains. The opening of the line is to take place on the 4th February by the Marquis of Salisbury. During the year several large machines for copper-depositing have been supplied. In addition to the above special contracts, a large number of Elwell-Parker dynamos and motors have been supplied for all sizes of installations in England and abroad.

Epstein Company. — This company write as follows: "In giving you, according to your request, a *résumé* of the work done by us during the last year, we propose to leave out of account the numerous batteries installed by us for lighting and other purposes where the working conditions call for no particular comment. The following instances of the employment of our cells under special circumstances are, however, we believe of interest, as evidencing the great range of usefulness combined with a degree of efficiency and durability unapproached by any other maker of secondary batteries. The tests of our cells by Prof. Ayrton, extending over seven months, and fully described in the enclosed copy of his report, give striking examples of their endurance under the most adverse treatment. Prolonged rests both after charge and complete discharge until the P.D. fell to 0, and subjecting them to a studied neglect difficult to match even in the worst conceivable actual practice, had no evil effects: the plates retained their full original capacity, and looked quite well. The large central-station cell exhibited by us at the Crystal Palace had likewise to undergo some curious hardships. This cell consisted of 31 electrodes altogether (15 + and 16 –), and according to our list had a capacity of two hours if discharged at the rate of 575 amperes. The plates were sent loosely, and burnt together into section at the Palace; the cell being then filled up with electrolyte preparatory to giving the initial charge. The charge had, however, to be delayed from day to day, owing to the heavy current required from the lighting mains and to the difficulty in procuring a suitable resistance to put in circuit without resorting to a liquid resistance, which, for some occult reason, was tabooed by the insurance authorities. Meanwhile was affixed the proud legend, 'This cell may be discharged at 1,000 amperes,' although the cell remained innocent of a vestige of charge for fully two months. Then the Edison and Swan Company made several gallant attempts to come to our rescue by constructing some special 75-ampere incandescent lamps to be used as resistances, at first unsuccessfully, but after a few weeks one or two held out, yet even then it was like filling a bath with a thimble, and the effort seemed lost on the cell. Thus it was left lingering until the request of the jury 'to discharge the cell before their very eyes at 1,000 amperes' came as a happy release, and was promptly complied with. The charge was then effected by means of a quantity of smaller cells sent from our works and joined in parallel, and the readings taken by Prof. Perry were as follows: Rate of discharge, 1,000 amperes; E.M.F. at 10.49 a.m., 1·95 volts; at 12 o'clock 1·8 volts, 1,183 ampere-hours; at 12.11½ p.m., 0 volts, 1,374 ampere-hours. The use of a secondary battery for lighting purposes on board ship is uncommon, and we would therefore instance an installation of our cells on board the steam yacht 'Vanadis.' With the choice between an auxiliary lighting plant and accumulators, the consulting engineer, Mr. F. Edwards, of 67, Bishopsgate, decided to employ the latter, specifying our cells for the purpose, the contract for the supply and erection of all necessary machinery being in the hands of Messrs. Crompton and Co., Limited. As besides the ordinary lamps, it was proposed to run a searchlight occasionally, the cells had to be capable of discharging at 125 amperes for three hours, while taking up as little room as possible. Our cells, type T 19, fulfilling these conditions were selected; but another difficulty had to be met. As the battery would not be used for four months from the date of installation, could we give an assurance that the cells would not permanently lose in capacity and become damaged through this long term of idleness, starting, of course, with a full charge? Yes, certainly we could and we did; and this question being settled, we set to work at once. Thick dovetailed teak cases, stout lead lining, everything as strong and as durable as possible, and as the 'Vanadis' has a heavy roll peculiar to her, careful provision against splashing out of the acid; also as the accumulators were located in close proximity to the ship's engines, the liberation of the fumes in the engine-room had to be scrupulously guarded against. Every difficulty was, however, successfully surmounted, and the whole contract carried out in a manner creditable to all concerned. The Russian Government, after having had one of our batteries in use for about 12 months, and expressing itself highly satisfied therewith, has, in the course of last summer, ordered a second large set of accumulators from us, which, after all, is the most substantial way of proving their good opinion of our cells. Far severer, however, than the work required from secondary batteries for lighting purposes either at central stations or when left to the tender mercies of the proverbial gardener, are the demands made on accumulators when employed for traction purposes. The frequent and not by any means gingerly handling they have to undergo for recharging, the vibration on the cars, and the sometimes excessive rates of discharge to which they are subjected more or less at each trip, try their constitution to the very utmost, and only the fittest can survive the constant strain. Six months' work for traction is more than equivalent to three years' work for lighting under ordinary circumstances, and this will help to understand the great difficulty which hitherto existed in producing a suitable cell. Robustness of construction, uniform distribution of active material so that no buckling can occur, and perfect adhesiveness of the same to the plate, proof against dropping out through vibration or sulphating, small compass with high-discharge capabilities, are qualities difficult to attain yet positively indispensable in a good traction cell, and without these none other can succeed. Our accumulators have now been in operation on the Birmingham Central Tramways Company's lines for over four months, the original order for six car outfits of 96 cells having been duplicated early in December, so that 12 sets will be running in the course of this month. All renewals of plates which may in time become necessary we have entered into an agreement to furnish against payment of a fixed maintenance rate of 1½d. per car mile, which low figure reduces the running expenses of the line substantially, and gives traction by Epstein accumulators a long lead over animal traction, and even over the trolley system. The batteries on the Birmingham cars are divided into four sections of 24 cells each, which, according to the requirements of the road, are switched in parallel or series. The cells in use there are of our type T 2 (4 + and 5 – electrodes) in ebonite boxes, eight in a tray, and conforming to our lists at the maximum discharge rate of 65 amperes, have a capacity of 150 ampere-hours. On steep gradients this maximum discharge rate has, however, to be considerably exceeded for a short time, reaching 150 amperes when the weather is favourable, and even 190 amperes when the road is bad, as during last December. Being discharged at much higher rates throughout the trip, the cells require, of course, earlier recharging, and in consequence of the additional handling receive double punishment. We are pleased to say, in conclusion, that the entirely satisfactory behaviour of our cells at Birmingham has been their best recommendation to other tramway companies who had watched their introduction and performance with great interest, and they will now be adopted on several important lines in a very short time."

Ernest Scott and Mountain, Limited.—This firm report very considerable progress in the electrical branch of their business during the past year. In fact, they have had to considerably extend their works in order to meet the extended business in this department, the turnover for the past year having been fully three times as much as the business done during the previous 12 months. Amongst the most important installations carried out by the firm may be mentioned the lighting of Benmore House, the residence of H. J. Younger, Esq., Kilmun, Argyleshire. This installation consists of a petroleum engine of 18 h.p., accumulators for 150 16-c.p. lamps and about 190 16-c.p. incandescent lamps and fittings throughout the house. They have also completed a large installation for Lord Ellesmere at Newmarket, this installation consisting of a steam-engine and boiler of 30 h.p., accumulators for 100 lamps, and 320 16-c.p. lamps throughout the house and training establishment. They have also completed the lighting of Mr. Walter Jones's private house at Blakemere, Hartford, Cheshire, this installation consisting of a steam-engine and boiler of 15 h.p., accumulators for 100 lamps, and 150 incandescent lamps throughout the house; and the firm have in hand at the present time the lighting of a large private house at Kirkby Lonsdale, for Mr. W. E. Padget Tomlinson. In addition to the above installations in private houses, the firm have been extremely busy in installations for collieries, ironworks, etc., and amongst the important may be mentioned a large set of electric pumping-machinery for the North Seaton Colliery, the plant being capable of delivering 300 gallons of water per minute against a head of 200ft. if required. In this plant the firm's improved arrangement of worm gearing has been adopted with great success. A smaller set of electric pumping-machinery capable of delivering 100 gallons of water per minute against a head of 150ft. was supplied and erected by them at the Newton Colliery. The firm have in hand for the Co-operative Wholesale Society two capstans driven by electric motors of 8 h.p.; these will shortly be at work One of the largest installations erected by them during the past year is the entire lighting of the Co-operative Wholesale Society's premises in Waterloo-street and Thornton-street, Newcastle. This plant consists of three Otto gas-engines, each capable of giving 60 brake horse-power, three compound-wound dynamos, each constructed to run 500 16-c.p. lamps, and between 1,100 and 1,200 lamps and fittings, together with accumulators for the night service. They have also completed the lighting of Mr. John Dickinson's engineering works, Sunderland, with 39 arc lamps of 2,000 c.p. and 3,000 c.p.; the lighting of Messrs. J. M. Bennett and Son's foundry, Manchester, with 10 arc lamps; and also the lighting of the Normanby Ironworks, Middlesbrough, with arc and incandescent lamps. The firm have in hand at the present moment the lighting of Messrs. Chadwick and Bros., Limited, mills at Bolton, this installation consisting of three 400-light dynamos and 730 16-c.p. incandescent lamps; and in addition to this are at present lighting the offices of the *Leicester Advertiser*, Messrs. T. H. White and Co.'s mill at Belfast, and also their London mills. In all the firm have turned out during the past year over 150 dynamos of various sizes and between 300 and 400 arc lamps, the total number of incandescent lamps installed exceeding 30,000. Messrs. Scott and Mountain inform us that they will have ready within the next week or so a new catalogue of electrical mining-machinery, of which they have made a speciality.

W. T. HENLEY'S TELEGRAPH WORKS.—The year 1892 has been one of continued success for this company. There has been an increasing demand for electric light and telephone cables, which has necessitated the opening of a second and commodious stock-room at Martin's-lane, Cannon-street, which is supplied with all their listed wires and cables ready for immediate delivery. The works of this company are undergoing considerable alterations and additions of buildings and machinery to meet the advance of trade. The chief event of importance was the successful laying of the Bahamas-Florida cable, manufactured at Messrs. Henley's North Woolwich works towards the close of 1891. This cable was laid from a point about five miles from Nassau, New Providence, to Jupiter Inlet on the south-east coast of Florida. The ss. "Westmeath" arrived at Nassau on the 14th of January last; the shore end at that place was laid on the 19th, and the vessel left for Jupiter, Florida, on the following day. The cable was of four types, the core throughout being $^{107}/_{140}$ guttapercha. The deep-sea cable was sheathed with 16 No. 13 galvanised wires; heavy intermediate with 12 No. 5; light ditto with 12 No. 8; and the shore end with 12 No. 1. The laying of the whole 215 knots was completed on the 4th of February, the line being formally opened for traffic the next day. The "Westmeath" then proceeded to New York, and picked up and successfully repaired the Western Union Company's New York-Canso cable, which had been ruptured by a ship's anchor. The Henley Company have been successful in securing some most important contracts for mains for municipal electric lighting. They have completed a contract for the ½in. cable for the Glasgow Corporation; the weight of this cable is 6¾ tons per mile, the conductor weighing five tons, and the insulating and protecting coverings 1¾ tons. They have also received a contract for supplying the arc light cables to the Corporation. The City of London Electric Lighting Company have placed with them considerable orders for the cables for lighting the City. Electric light mains have also been manufactured for various supply companies in London, and several cities and towns at home and abroad. Contracts for Government have been received, and cables despatched to various stations in India, etc. Large shipping orders from Governments abroad have been carried out for telephone, electric light, and torpedo cables. Among the contracts Messrs. Henley have in hand is one for about 250 knots of submarine telegraph cable for the West India and Panama Telegraph Company, Limited. We may mention this company was awarded a gold medal at the Crystal Palace Electrical Exhibition, 1892.

J. H. HOLMES AND CO., electric light engineers, Portland-road Works, Newcastle-on-Tyne, have during this year made good progress of fitting in complete installations of electric light of various kinds, the total number of installations being over 100, including over 50 steamships, and a large variety of houses, cotton mills, public buildings, collieries, shops, etc—all these installations being fitted complete with electric generating plants, wiring lamps, etc. Some of the most important installations may be mentioned—namely: The Glasgow Athenæum, 2,000 lights; Aberdeen Royal Infirmary, 850 lights; Cannon-street Hotel, London, 800 lights; Armfield's Hotel, London, 300 lights; Maple and Co., London, 1,200 lights; Haworth and Co., mills, Manchester, 3,000 lights; the Peel Company's Mills, Bury, 1,300 lights; M. Yates, mill, Bramley, 1,000 lights. This firm has also installed the electric light on yachts for his Serene Highness the King of Siam and J. F. Laycock, Esq., Newcastle, now completing at Leith, and one, Mr. Gordon Bennett's yacht, being fitted at Birkenhead. The generating plants supplied to these and other installations fitted during the year, have an output of about 30,000 16-c.p. incandescent lamps. Messrs. Holmes and Co. have also lately supplied seven large dynamos to an important steel company for electric welding purposes for working under the Benardos process, which was mentioned by Mr. Swan in his lecture at Newcastle, referred to in our issue of December 23, page 627. Messrs. Holmes and Co. are also building some large dynamos for central-station work, to be used in town-lighting. These machines are all of the improved construction, giving an unusually high efficiency. With regard to the amount of work on order at the present time, they are fairly well employed, and have sufficient to keep them going for several months of the new year.

JOHNSON AND PHILLIPS.—During the past year the St. Pancras electric lighting has been completed, to which the firm have supplied the dynamos, arc lamps, machinery, etc., for the whole of this important installation, including the lighting of the station itself. The plant is of the direct-current system, and is capable of supplying 20,000 16-c.p. incandescent lamps, and upwards of 100 arc lamps. The dynamos are six-pole machines of the Kapp central-station type, and the arc lamps are of the well-known Brockie-Pell street pattern. The latter are mounted on lampposts of special design, placed in the middle of the roads. The plant has now been in operation since the early part of the year, and is working with the greatest success. This is the only instance at present in London of a parochial authority retaining in its own hands the supply of electricity for public lighting. The Metropolitan Electric Supply Company, which supplies the West-Central district of London, has had its large central station in Paddington equipped with complete alternating-current machinery of this firm's manufacture. The alternators are Kapp's patent, and are separately excited. The engines are of the open horizontal type, and the boilers are of the locomotive type. The switches are mounted on white marble slabs, and present a very good appearance. The total capacity of the machinery is 10,000 16-c.p. lamps. The firm are just on the point of completing an important installation of high and low tension mains for the public supply of electricity to Chatham and Rochester. The system employed is Brooks's patent underground system with liquid insulation. The voltage will be 2,400 for the high and 110 for the low pressure. They have also supplied large numbers of Brockie-Pell arc lamps for the public street-lighting of Dublin. They have lately completed, for a gentleman's country house, a novel electric light installation, the motive power of which is a windmill. It is absolutely automatic in its action, and entirely dispenses with skilled labour, or, in fact, any labour. In open country and exposed situations, where the wind has free and uninterrupted play, this form of power stands unrivalled in point of economy. The business in Brockie-Pell arc lamps, of which Messrs. Johnson and Phillips are the sole makers, continues to increase, and they have made more this year than in any previous twelve months. They are sent to all parts of the world. Simultaneously with the erection of new and larger premises for the manufacture of electric cables and wires, there has been a considerably improved business in this branch. The business in D. P. storage batteries is steadily increasing, and this year more than ever have been turned out. The firm have lately completed an important cable-making plant for a large continental firm of cable manufacturers, consisting of deep-sea and shore-end sheathing machines, taping and compounding machines, hauling, winding, and draw-off gears. The plant includes a machine for shore-end work, which is one of the largest of its class in the world.

Laurence, Scott, and Co.—This firm has been well employed during the past year, although there has been a great falling off in one branch of the business—namely, the manufacture of direct-driven plants for shiplighting. The reason of this is obvious. Several important firms of electric lighting contractors have taken up the "Scott-Sisling" system, and plants on this system have been supplied to Messrs. Barclay and Son, London, W.; Messrs. Bland Bros., Newcastle-on-Tyne; Messrs. R. H. Barnett and Co., Newcastle-on-Tyne; Mr. C. Green, Okehampton, Devon; Mr. W. A. Bezant, Leamington, etc. An important part of the year's business has been the contract with the Norwich Electricity Company, Limited, for the complete equipment of their central station. This is well advanced, although a long delay, owing to difficulties in the foundation for the chimney shaft, has put things very much behind. There will be several new features in the central station. The accumulators, which are of comparatively small capacity for keeping up the supply during the lightest load, will be charged off the lighting mains, instead of a machine being run specially for charging them, as in the usual way, the extra pressure required being obtained by the secondary of a small transformer placed between one of the mains and the cells. This will enable the engines to be run at more nearly their full load. The engines are to be Willans G.G.S. triple transfer. They will be run condensing, the central station being on the banks of the river. The condensing arrangements will consist of a separate ejector condenser to each engine supplied by an overhead tank, into which the water will be delivered by means of a pair of centrifugal pumps, each driven by a separate electric motor. The electricity meter which this firm has been manufacturing has, during the year, entered into a new development; this was described in our issue of the 16th December last. The special meter wires necessary for this system may at first sight seem to be a very serious objection to it, but the almost ideally perfect arrangement of differential charges that is possible with the system, together with the simplicity and very small wear and tear involved in the action of the meter, must, it is thought, eventually overcome this objection.

Liverpool Electric Supply Company.—This company has fitted up numerous electric light installations during the past 12 months, amongst which we may mention the lighting of Knowsley Hall, for the Earl of Derby, 1,070 lamps; North-Western Hotel, for the London and North-Western Railway Company, 600 lamps; and Wapping warehouses, for the Mersey Docks and Harbour Board, 150 lamps. The number of lamps supplied from the company's central stations has increased by about 5,000 lamps during the year—the total number of lamps connected to their mains being over 19,000 16-c.p. lamps. During the year a new station has been built for the supply of electric light to the residential district of Sefton Park, Liverpool.

A. P. Lundberg reports that during the year he has had plenty of work in hand, especially during the latter half, necessitating a considerable increase in the staff. A new switch known to the trade as the "Unique," brought out in the spring, has become exceedingly popular with electrical engineers at home and abroad, and licenses for the manufacture of this switch have been granted to responsible firms in Great Britain and abroad. Should the demand for these switches increase in the same proportion as they have done in 1892, an increase in the size of the firm's present premises will be necessary. Premier position must be accorded to this switch, though some of the firm's well-known specialities are in considerable demand, the introduction of some of which dates back as early as 1882. It is satisfactory to note that over 15,000 "Unique" switches have been sold of various sizes and modifications during the short time they have been on the market. It has been considerably in demand as a two-way switch for hotel, bedroom, staircase, or corridor lighting, and has been adopted by some of the leading London and provincial hotels for that purpose. In combination with a wall socket it has been extensively used in many important installations at home and abroad. The "Unique" switch was exhibited at the Crystal Palace Electrical Exhibition, 1892, and was awarded a medal in conjunction with other novelties. Prominent among novelties, the firm is about to introduce a new wall socket which will commend itself to electrical engineers on account of its simplicity and reliability.

James Menzies and Co.—This firm has had a very considerable amount of business from the various electric companies during the year, more especially from the City of London Electric Company, to whom they have supplied about 200 miles of wrought-iron tubes for their mains throughout the City. They have also supplied a considerable quantity to the Hull Corporation, and even a few steel tubes to the City of Glasgow Electric Company, but in this latter case, we understand, they are laying their mains in cast-iron insulated troughs. There has been some doubt thrown upon this system, and it remains to be seen whether it will be a success. It is somewhat cheaper at first, but the wrought-iron mains, as used in London, appear to be considerably more substantial. The wrought-iron tube trade, on the whole, has nothing to complain of with regard to electric companies. It was stated some years ago that this trade would suffer more than any other from the substitution of electric lighting instead of gas, as the gas companies are large customers of wrought-iron tubemakers, but it has proved quite the contrary. Where the electric light has been used, there have been more wrought-iron tubes used for mains than there would have been had there been a gas installation.

Mosses and Mitchell.—This firm, notwithstanding the almost universal depression of trade, are able to report steady progress in the sale of hard and flexible vulcanised fibre sheeting, washers, etc. Their marine fibre valves still retain the good opinion of the mercantile service after some eight years' test. During this year they brought before the electrical world their new "insulating saddle staples," and these are so much liked by the trade that they cannot at the present moment execute all the orders.

Paterson and Cooper.—Notwithstanding the somewhat depressed condition of the electrical engineering trade, Messrs. Paterson and Cooper have succeeded in securing a fair share of work. In shiplighting, which is one of their specialities, the following work has been done: the ss. "Carthaginian," for the Allan Line; the "Empress of the East"; the steam yacht "Vanduara," for Stewart Clark, Esq., Paisley; the Clyde Shipping Company's steamers "Sanda," "Dungeness," and "Longships"; the ss. "Cuidad de Cadiz," built by Messrs. Lobnitz, of Renfrew; the new ss. "Peregrine," of the General Steam Navigation Company; the North of Scotland, Orkney, and Shetland Steam Navigation Company's ss. "St. Giles"; and the training ship "Shaftesbury." Of ships in hand there are at present the ss. "Polynesian," of the Allan Company; the ss. "Princess Beatrice," for Messrs. Langlands and Co., Liverpool; and the ss. "Matin," for Messrs. Mudie and Sons, Dundee. A number of direct-driving sets and other shiplighting plant have been supplied for vessels wired by other firms and for vessels built abroad. A fair amount of installation work has been done, the principal being for Messrs. Gregory and Sons, Royal mail contractors, Jersey; Messrs. Lipton's establishment at Southampton; the private residence of E. Cox, Esq., Cardean, Perthshire; the Royal Mail Steamship Company's offices; the Imperial Ottoman Bank; Union of Canton Insurance Company; Messrs. Mowlem and Co., Guernsey; the new floating bridge, Portsmouth; and Broad-street House, E.C. The large installation at the *Daily Chronicle* offices has been finished, and extensions are being made to the 1,600-light installation at Messrs. Nelson and Co.'s refrigeration stores and wharf, a number of motors for ventilation having been erected. The principal installations in hand are Messrs. Lipton's establishment, Glasgow; Messrs. Workman, Clark, and Co.'s shipbuilding yard at Belfast; the Eastern Club, Dundee; the Northern Assurance Company, Dundee; the Market Hall, Hull; and the private residence of H. W. Buddicom, Esq., Penbedw, Mold. In manufacturing departments a fair average has been maintained. Although somewhat below last year, the output of dynamos has been satisfactory. A considerable business has been done in measuring instruments, several large orders having been received from abroad. The output of arc lamps, switchboards, and general electrical apparatus has also been fairly maintained. The immense amount of business being done in the metropolis is exemplified in the wiring and installation work carried out, the employers getting current from the supply companies. Messrs. Paterson and Cooper have carried out a lot of this class of work, among which we may mention Messrs. Brown, Shipley and Co., the Colonial and Mutual Insurance Company, Messrs. Bullard, King, and Co., Messrs. Alexander Lawrie and Co., the China Traders' Assurance Association, Messrs. Pollard and Co., the Sea Insurance Company and Messrs. Willis and Co., the Union of Canton Insurance Association, Messrs. Parker and Thomas, United States Lands Investment Company, the Salvation Army Headquarters, Royal Mail Steam-Packet Offices, the Imperial Ottoman Bank, F. Austin, Esq., Messrs. Collett and Co., James Walker, Esq., Isambard Brunel, Esq., Baker's Hotel, the New Victoria Concert Hall, J. T. Drew, Esq., Messrs. Hudson, the Hon. T. R. Vernon, Colonel Ollivant, Charles Goolden, Esq., Dr. Tyrrell, Dr. Gordon, R. E. Noble, Esq., Messrs. Lipton's, Messrs. Morris and Co., Messrs. Sedgwick and Co., and W. Bald, Esq.

Ronald A. Scott.—A considerable portion of the work during the past year which has been turned out from the Acton Hill Works has been in fulfilment of orders for the navy, the whole of the distributing-boxes used in the navy having been ordered from this firm, as were all the switchboards. Besides this class of work the installation on board the steam yacht "Utowana" has been refitted. Mr. Ronald Scott has made a speciality of searchlight plant, and a complete set of such plant has been sent to Indis. He has also supplied a quantity of 24in. and other types of projectors to the Government. Quite recently a new departure has been seen in London—a projector of 30,000 c.p. having been erected on the roof of the New Palace Theatre, for which the necessary fittings and cable were also supplied. The electric light gear for the Indian Government, for H.M.S. "Clive" and "Canning" were supplied by this firm. At present a number of large dynamos for the Government are being constructed. An installation has been fitted out at 52, Welbeck-street, for the supply of about 300 lights. Another installation at Messrs. Pratt and Sons, Covent Garden, is also being carried out. It will be remembered also that Mr. Scott initiated a series of experiments for the use of searchlights for military purposes, experiments being carried out during the volunteer manœuvres at Elstree, at Wimbledon, and Perivale. Towards the end of the year considerable interest has been taken in the method of projecting to a distance words and pictures by means of the electric light. Altogether, the works have been and are busily employed.

Swinburne and Co. have to report a very satisfactory 12 months' working. During this time their business has considerably increased in all its branches, both English and foreign. More particularly they have to report a great extension in their foreign connection. The firm have only within the last two or three months taken up the manufacture of dynamos, and they have already orders for several hundreds of horse-power in these machines, and they expect a considerable development both in this branch and that of their standard switchboard instruments, which are taking very well. Somewhat slack during the three summer months, the firm have had a heavy press of work ever since, and contemplate an extension of their premises in the spring.

Vaughan and Brown.—As an example of the activity in the London district, and the spread of electric lighting, we may give a list of the works executed by this firm during the past year: Shaftesbury-mansions, the Raleigh Club, S. Skinner, Esq., W. Wood, Esq., J. Willings, "Bewlays," Polytechnic, Lines and Son, Harris and Son, the Washington Restaurant, "Kettners," the Boar and Castle public-house, Adelphi Stores, Shepherd and Flock, Cannon, Peacock Tavern, Castle, Bun Shop, Daniel Lambert, Old London Coffee House, Chandos, Princes Head, Globe Hotel, Bedford Head Hotel, Trafalgar-square Theatre, New Palace Theatre (over 1,000 lights, also very handsome fittings, electroliers, brackets, etc.), Sexton's large horse repository. A complete installation has been put in at the Royal Albert Music Hall. The firm is at present engaged upon the Prince of Wales and Globe Theatres, Hotel Metropole, Margate; Boar and Castle, Oxford-street; Flying Horse, Oxford-street; Blue Posts, Tottenham Court-road; Messrs. Faulkner's tobacco factory, Blackfriars-road; Messrs. Scriven's printing works, Fleet-street; and Dr. Waugh's, 86, Wimpole-street, W.

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to the 21st of December, 1892, under the provisions of the Electric Lighting Acts 1882 to 1890:

Title of Order and Description of Area.	Name of Promoters.
Altrincham and Bowdon Electric Lighting Order. The Local Board Districts of Altrincham and Bowden and a portion of the District of the Rural Sanitary Authority for the Altrincham Union.	Manchester Edison-Swan Company, Limited.
Barnet Local Board Electric Lighting Order. The District of the Local Board.	The Local Board.
Beckenham Electric Lighting Order. A portion of the Parish of Beckenham.	The Local Board.
Bridgend Electric Lighting Order. The Urban Sanitary District of Bridgend.	The Local Board.
Brighton Electric Supply Order. The Municipal Borough of Brighton.	Brighton and Hove Electric Light Company, Limited.
Colchester Electric Lighting Order. The Borough of Colchester.	The Corporation.
Eccles Electric Lighting Order. The Municipal Borough of Eccles.	The Corporation.
The County of London.	
Hackney Electric Lighting Order. The District of the Board of Works for the Hackney District.	The Board of Works.
Hammersmith Electric Lighting Order. The Parish of Hammersmith.	The Vestry.
Islington Electric Lighting Order. The Parish of St. Mary, Islington.	The Vestry.
Islington Electric Lighting Order. The Parish of St. Mary, Islington.	County of London Electric Lighting Co., Limited.
Poplar District Electric Lighting Order. The District of the Board of Works for the Poplar District.	The Board of Works.
St. Mary, Islington (North), Electricity Supply Order. A portion of the Parish of St. Mary, Islington.	Holloway Electricity Supply Company, Limited.
Newcastle-upon-Tyne Electric Lighting Order. The City and County of Newcastle-upon-Tyne.	Newcastle-upon-Tyne Electric Supply Co., Limited.
Newmarket Electric Lighting Order. The Urban Sanitary District of Newmarket.	British Electric Light Company, Limited.
Partick Electric Lighting Order. The Burgh of Partick.	The Commissioners of Police.
Reading Electric Supply Order. The Borough of Reading.	Reading Electric Supply Company, Limited.
Taunton (Corporation) Electric Lighting Order. The Municipal Borough of Taunton, and a portion of the District of the Taunton Union Rural Sanitary Authority.	The Corporation.

OBITUARY.

The news is received of the death of Marmaduke M. M. Slattery, whose name is known generally throughout America in connection with the Fort Wayne system of lighting. He was born in Limerick, Ireland, in 1851, and was educated at Marlborough College, obtaining a B.A. degree in 1873. He was associated in the early days with Mr. Lane Fox in experimental work, and went to America at the time of the electric lighting boom in 1880. He joined one of the prominent New York companies, but afterwards went to Fort Wayne, Indiana, where he developed the very successful alternating-current system which was associated with his name. Mr. Slattery had lately given much attention to storage battery work. He was greatly liked among the electrical fraternity, and, possessing considerable literary ability, was a well-known member of the Boston Society of Arts.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VI.—OHM'S LAW AND THE ELECTRIC CIRCUIT.

(Continued from page 585, Vol. X.)

Simple and Divided Circuits.—The most simple electric circuit possible is shown in Fig. 6; in this, as well as in any other circuit, simple or divided, the whole circuit may be classed into three distinct portions—namely, (1) the generator, or source of electricity, (2) the conducting wires, with switches, etc., (3) the source of light, heat, or power.

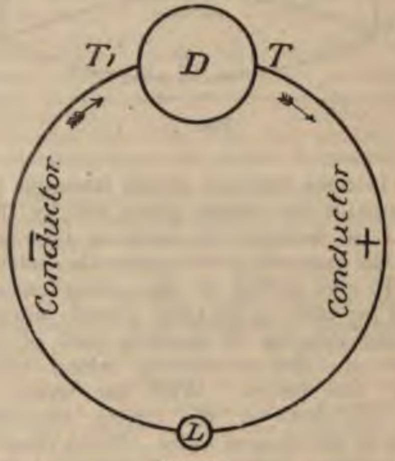

Fig. 6.

As a generator, the dynamo is mentioned, and the electricity so produced, after being guided whither it is required, is made to do work by producing a source of light as an arc or incandescent lamp, by producing heat, as an electric heater, or by producing mechanical power, as an electromotor.

The first portion of the circuit, that of the dynamo, and limited by T_2 T_1 on either side, is known as the internal circuit, whilst the other two portions, those belonging to the conducting wires, and the lamp, or other apparatus, are known as the external circuit.

In Fig. 6, T signifies the positive terminal of the dynamo, where the electricity is supposed to make its exit, or flow into the external circuit at T_1; it leaves the external circuit and completes the circuit by entering the generator, whence it came. The distinction between E.M.F. and difference of potential has been fully explained, and here we can now with advantage apply this distinction. The E.M.F., or maximum difference of potential, has its seat in the coils of the armature of the dynamo, and is that which urges the flow of current through the whole of the circuit, external and internal, so that the current starting from one point of the armature coils enters the external circuit by the terminal T, flows along the conducting wire, through the lamp, back through the other conducting wire, and so by terminal T_1 into the armature coil whence it started, thus completing the entire circuit. It is evident that a certain amount of potential will be lost by forcing the current from its starting point to the terminal T, because the current has to be urged through the resistance offered by the wire comprising the armature coils and the field-magnet coils. Again, a certain amount of potential will be lost by forcing the current from the terminal T_1 back to its starting point, again due to the resistance offered by the armature coils and the field-magnet coils. Multiplying the internal resistance, which is that between the two terminals, T and T_1, by the square of the current flowing, or what amounts to the same thing, multiplying the drop of potential between T and T_1 by the current, will give the electric energy that is lost in the dynamo. The second portion of the circuit comprises the two conducting wires, one leading to the lamp, called the positive or + wire, and the other leading from the lamp, called the negative or − wire. Both may be taken as similar; therefore, multiplying the resistance of the two wires by the square of the current will give the electric energy lost in the two conductors.

The third, or remaining portion, is the lamp, or other apparatus, and the energy utilised here is obtained in a similar way. Adding the three results together gives the total energy generated by the dynamo, and since the energy that is sent into the external circuit (through the conductors and lamps) is the amount given out by the machine, hence the ratio between the total, or internal + external power, and the external power gives the efficiency of the machine. To give an idea of the various losses, it may be said that 10 per cent. of the total electric power developed is lost in the internal or machine part of the circuit, 5 per cent. in the conducting wires, and the rest utilised in the lamps. With the same amount of current in all parts of the circuit, the loss will be proportional to the drop of volts. Using these values, and having a working difference of potential between the terminals of the dynamo of 100 volts, the maximum potential in the internal circuit may be about 112, six being lost. Upon reaching the positive terminal, the potential there will be 106. Allowing 2½ per cent. for the positive conductor, we have about 103 at the point of the circuit where the current enters the lamp. On passing through the lamp the resistance is very high, and it is here that the power is utilised, so that on coming out of the lamp the potential is very low, say, only nine. Allowing an equal drop along the negative conductor, we have a potential of six at the negative terminal of the machine, the remaining six being lost in the internal circuit.

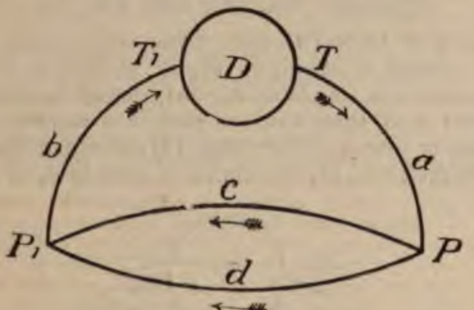

FIG. 7.

We have discussed the resistance of a circuit when there is only one path for the current to flow along, but what effect upon the current would divided paths have? This is a matter that may lead to complicated calculations where the divided paths are numerous and of irregular resistance, etc.; so we will begin with the simplest and gradually work towards those not so simple, and when a certain limit has been reached more advanced problems will merely be referred to, since they would not be suitable here.

Study Fig. 7. At the point P of the conductor *a* it will be seen that the conductor divides into two paths, *c* and *d*; let each have the same length and the same diameter, this diameter being the same as that of *a* and *b* at the point, P_1, *c* and *d* join together or to the conductor *b*. Resistance is inversely proportional to cross-sectional area, therefore the combined area of *c* and *d* must be double that of either of them alone; hence the combined resistance must be one-half of either of them alone. The amount of current in a circuit is the same at all points, so that whatever current flows past the point P of *a* into the two divided paths, *c* and *d*, the same amount must arrive at the point P_1 of *b*. The area of *c* is equal to the area of *d*, hence the current will divide equally at P; one half going through *c*, the other half going through *d* at P_1 the two halves unite again. Putting the resistance of *c* and *d* at 10 ohms each, the combined resistance will be 10 ÷ 2 = 5 ohms, and if 50 amperes flow past P, 25 will flow past *c*, and 25 past *d*. If *a* and *b* were divided into four paths, instead of two, all four having the same diameter and the same length, consequently the same resistance, then the combined resistance of the four would be one-fourth of that offered by a single one; hence the current would split into four paths, and for any number of paths having equal resistance, the combined resistance is obtained by dividing the resistance of a single path by the number of paths there are,

or,
$$R = \frac{r}{n},$$

where R = the combined or total resistance, r = the resistance of a single path, and n = the number of paths.

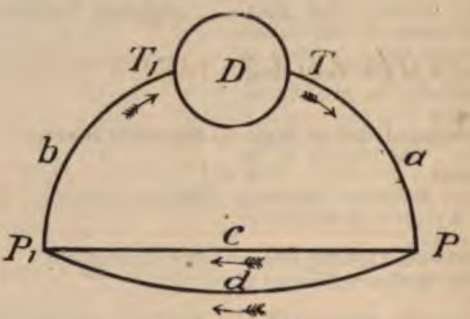

FIG. 8

When two or more paths are open to a current these paths are said to be in "parallel," so that the two wires, *c* and *d*, in Fig. 7 are in parallel. When the end of one path is joined on to the end of another path so as to make one continuous length, then these two paths are said to be in "series," so that the single path, *a*, is in series with the divided paths, *c* and *d*; also *c* and *d* are in series with the single path, *b*, hence *a*, *c* and *d*, *b* are all in series, and the total resistance of these three paths would be resistance of *a* + combined resistance of *c* and *d* + resistance of *b*. Let *a* = 20 ohms, *c* = 5 ohms, *d* = 5 ohms, and *b* = 20 ohms. The first thing to be done is to find the equivalent or combined resistance of *c* and *d*; this is, 5 ÷ 2 = 2·5, so that the combined resistance of the two paths, *c* and *d*, is the same as if they were replaced by a single path having a resistance of 2·5 ohms. All being in series, the total resistance is 20 + 2·5 + 20 = 42·5 ohms. In Fig. 8, the calculations are a little more difficult. We have again a divided path between the two points, P and P_1, and the two conductors, *c* and *d*, have in this case unequal resistances, due, say, to length, therefore *c* is drawn shorter than *d*. We will first find the combined resistance and then the way the current divides itself. When treating of unequal resistances, it is convenient to convert them into conductivities, and having found the value of the combined conductivity of all the paths, to then reconvert them into combined resistance. Conductivity of a path is in inverse proportion to the resistance, and resistance is in inverse proportion to the conductivity—that is, putting k for conductivity and r for resistance, we have $k \propto \frac{1}{r}$ and

$r \propto \frac{1}{k}$; so that the conductivity is the reciprocal of the resistance, and *vice versâ*. Instead of considering two resistance paths we will consider two conducting paths, one of which conducts better than the other because it has less resistance than the other. It is evident that the combined conductivity of the two conducting paths is equal to their sum; giving a resistance of r_1 to c, and r_2 to d, their respective conductivities will be $\frac{1}{r_1}$ and $\frac{1}{r_2}$.

Hence,

$$\text{Combined conductivity} = \frac{1}{r_1} + \frac{1}{r_2},$$

and putting R for the combined resistance, we have $\frac{1}{\mathrm{R}}$ for the combined conductivity;

therefore
$$\frac{1}{\mathrm{R}} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_2 + r_1}{r_1 \, r_2},$$

and converting conductivities into resistances, we get

$$\mathrm{R} = \frac{r_1 \, r_2}{r_1 + r_2}.$$

Putting the above law into words, this means that the combined resistance of two unequal resistances in parallel is obtained by dividing their product by their sum; for let the resistance of c be 15 ohms, and that of d be 20 ohms, then the combined resistance will be

$$\frac{15 \times 20}{15 \times 20} = \frac{300}{35} = 8{\cdot}57 \text{ ohms.}$$

(To be continued.)

COMPANIES' MEETINGS.

YORKSHIRE HOUSE-TO-HOUSE COMPANY.

The ordinary general meeting of the shareholders of the Yorkshire House-to-House Electricity Company, Limited, was held on December 28th at the Great Northern Railway Station Hotel, Leeds. Mr. Grosvenor Talbot (chairman of the Directors) presided. The report of the Directors was taken as read.

The **Chairman**, in moving the adoption of the report and statement of accounts, said the meeting, which was held before any accounts could be returned of revenue, really required very little to be said by him. When the present Directors came into office there was very little time left for them to settle what they were going to do before the date came when all the preliminary work must be settled; for the prospectus was only issued on the 26th of March, and on the following 4th of April all the necessary requirements of the provisional order had to be complied with—that was to say, they had to get an amount of share capital which they considered would justify them in commencing their work, and they had to pay £5,000 down to the Board of Trade to show that they were in earnest in what they were about to do. That was done, but it was done by the strenuous exertions of the Directors, and by holding daily meetings from the time of their appointment till the 4th of April. The Company had in its hands the power of lighting the whole borough of Leeds by electricity—a power which, he was advised, would not be interfered with as long as the Company provided sufficient light and gave all reasonable requirements to the inhabitants of the borough. When they had got this order and all preliminary matters settled, the first business was to obtain land. They advertised for land in those positions which they thought would meet their requirements, and they had a considerable number of replies. The sites offered were all inspected, but they came to the unanimous conclusion that the site they had purchased in Whitehall-road was by far the best. That site was more expensive than they thought they would have to give for their first instalment, but the Directors considered that the outlay of that money was the best in the end. They were receiving a considerable income from premises erected on the site, and which were not at present required by the Company, but as an electric lighting station the site had many most admirable requirements. In the first place, it was on their line of lighting, as they had only to cross the road to Wellington-street, and that allowed them to save an amount of money in the initial cost of cables, and to lessen the expense of cables and repairs. Another advantage was that by getting that station they acquired the right of taking water from the river, and by a small expenditure in filters, they had got the very best possible water for their purpose, at no cost at all. The site was on the bank of the river, where previously there was a coal wharf, and they could receive all their coal by the river, so that they would be great gainers by the cheapness of coal, and by having to pay nothing for water. Another advantage was that they would require no offices in the centre of the town, as an office at the central station would be quite requisite for their purpose. They had begun the work with a body of 109 shareholders, who had taken up 7,298 shares, and it would be seen by the accounts that they had left £6,000 on the land and premises, so that they considered they had now started with capital sufficient fully to work the instalment which they had commenced with. When they had got their site, there came the question of the system to be adopted, and the means of carrying that system out to a successful issue. A system of electric lighting was a matter of such an extremely technical character that the Directors had to take largely into consideration the opinion of their electrical engineer. They found that the system which Mr. Hammond advised was a system in operation in other towns similar in their character to Leeds, and they, therefore, were glad to take up the system as recommended. But they did not wish to take up that system on their own responsibility, or on the responsibility of Mr. Hammond, and they put his plans and specifications before Mr. Preece, the celebrated engineer to the Government, and he endorsed the plans as being admirably adapted to the work in hand. Having settled their system, they invited tenders for their plant, and they received large numbers. These were exhaustively gone through by the engineer, and were compared in every way, both for cheapness, productiveness, and strength, and he reported to the Directors. The firms they decided to give the contracts to were all firms of the highest status; and in addition to that, they asked two of the Directors who were eminently qualified by their technical knowledge to go through the plans and tenders, and see if they could suggest any improvements on the plans recommended by Mr. Hammond. These gentlemen did so, and several improvements which they thought would add to the strength of the machinery were cheerfully adopted by the contractors for the work. All this plant had been manufactured. The dynamos were waiting to be delivered, and the engines were waiting to be put down as soon as the roof was on. He was glad to think that in making these contracts the price which Mr. Hammond had estimated had not been exceeded to any appreciable extent. There had been some delay in the erection of the buildings, and some delay in getting foundations which were considered by the architect amply sufficient for the work which had to be built upon them. With regard to lighting, they had received applications for 8,000 lamps of 8 c.p. each. That was a very large number of lights to be applied for absolutely before the town had had an opportunity of seeing the light in operation, and he had no doubt himself that before the works were fully in operation they would have as many lamps applied for as they were able to supply. They must remember that they could quadruple their machinery on the spot where they were, so that when the time came for an increased supply there would be no delay. They would put down fresh machinery as soon as it was required to meet their wants. In erecting this plant he thought they might congratulate themselves upon the period for commencing their work. Iron and steel, both of which entered largely into the composition of their work, were cheap; copper, which entered into their cables, was also very cheap, therefore they had begun at a time when if any company could make it pay they ought to do so. They had got all their mains laid in the district where they were going to supply their first instalment, and also the cables, except up Headingley-lane, so that directly they had their machinery in operation they would be in a position to light every lamp for which they had an application. He trusted that that, their first meeting, would be an augury of a successful system of electric lighting for the borough of Leeds.

Mr. R. W. Eddison seconded the resolution.

Mr. R. Hammond, in supporting the resolution, remarked that he would like to say a few words upon the industry in general, and especially as to the reasons why it was deemed advisable to secure this provisional order in Leeds. The passing of the Electric Lighting Act of 1888, which amended the Act of 1882, was considered by those in the industry as a great step in advance. Under the old Act there was power of purchase given to local authorities at the end of 21 years. Capitalists were not inclined to invest their money under such circumstances, and the curious thing happened that not any single scheme was carried out under the old Act. They agitated for some years for an amendment of the Act, and in 1888 an Act was passed by which the power of purchase was extended from 21 years to 42 years. It was then that the founders of this Company considered that there was a large field in Yorkshire for the laying down of central stations, and that Leeds, among other places, certainly afforded a very splendid field for electric lighting. But there was one particular clause in the Electric Lighting Act of 1888 which made it extremely difficult to obtain provisional orders where the local authorities were opposed to them. It provided that the local authorities had to give their consent to the entrance of the electric lighting company before the Board of Trade was approached. Shortly after the passing of the Act of 1888, when the Company applied to the various authorities throughout Yorkshire, it was met in almost every case with the reply that if electric lighting appeared to be so good a business, the towns preferred to do it themselves. Leeds was among the towns that so replied, and it appeared at one time as if the Company would not be able to obtain any provisional order. The Electric Lighting Committee of the Council made up their minds to do the work, but it was not confirmed by the Corporation, and the Yorkshire House-to-House Electricity Company eventually obtained the provisional order. It was necessary to consider the arrangement of the terms of purchase, if the Corporation of Leeds was not disposed to grant powers to the Company which would give it an unfettered tenure for 42 years. He had a great deal to do with the negotiations which resulted in terms of purchase which were deemed to be extremely fair. The Lee-

Corporation had the power of acquiring that undertaking at any time on giving a sufficient amount of Leeds Corporation stock to secure 5 per cent. per annum upon the amount expended by the Company. With regard to the oft-repeated rumours that electric lighting companies in the past had proved failures, he would like to say it was not true that electricity supply companies had proved failures. With the exception of a little place at Ipswich, which only obtained its order last year, and did not make a fair start, there was not a single instance of a company for the supply of electricity which had not met with success. They must discriminate between the old companies that were got up for trafficking in patents, and those which were now formed for the supply of electricity. He felt extremely confident that the industry in which they were engaged in Leeds was a sound one, and he was able to feel that confidence all the more when he saw the returns which were now made annually to the Board of Trade of the electricity supply companies, and was able to analyse the actual cost of production, which was such as to make him second most warmly the remarks of the Chairman, that at the station in Leeds it would be possible to produce electricity more cheaply, or as cheaply, as at any other place in the kingdom. Looking at the question from a consumer's point of view, he said it was manifestly of great advantage to the tradesmen of Leeds to have the electric light. There was hardly a business which was carried on in Leeds of which it could not be said the electric light would show the goods off better, and would deteriorate them less than any other form of illumination. It was a satisfaction to a body of shareholders to feel that they were engaged in something that was distinctly benefiting the town.

The resolution was adopted.

On the motion of the **Chairman**, seconded by **Mr. J. T. Pearson**, the appointment of the Directors was confirmed.

Mr. Grosvenor Talbot and Mr. R. W. Eddison, the retiring Directors, were re-elected, and Mr. John Gordon, jun., was appointed auditor.

The **Chairman** said that many gentlemen might know that they had put down temporary plant. They had been able to obtain an excellent engine for a short time at a rent of so much a month; they had used one of their own dynamos, and they had had a shed rented to them by the Midland Railway Company. They had an instalment of a limited number of lights, which had proved eminently satisfactory to everybody who had used it.

Mr. Hammond, in proposing a vote of thanks to the Chairman, alluded to the temporary plant, remarking that the shareholders would be glad to know that while they had made an estimate that they would supply a certain number of units by it nightly, they had supplied double as much, and if everything went on at that pace it showed how healthy the business was.

Mr. Redmayne seconded the resolution, which was adopted, and the meeting was brought to a close.

ELMORE'S WIRE MANUFACTURING COMPANY.

The second annual ordinary meeting of the shareholders of Elmore's Wire Manufacturing Company, Limited, was held immediately after that of Elmore's Patent Copper Depositing Company. It was presided over by the same chairman (Mr. J. Jepson Atkinson).

The **Chairman** formally moved the adoption of the accounts, and this was seconded by **Mr. Hays.**

A **Shareholder** said he would like to know when the wireworks were to be in operation

The **Chairman** explained that fairly good progress had been made, and that in all probability the wireworks would be in full working order in a week's time.

Mr. Johnson also assured the meeting that the wireworks would be started in earnest next week..

A **Shareholder** said that he had been to see the works for himself, and expressed himself as being perfectly satisfied with the progress that had been made.

Another **Shareholder** observed that he thought it had been understood that there were orders in hand as far back as two years ago.

The **Chairman** : So we had.

Shareholder : Then why were they not executed ?

Mr. Hays : Because we had not sufficient money.

Mr. Johnson : What applied to the former company applies equally to this—it was largely in want of funds.

The **Chairman**, in reply to a question from a shareholder, said that it was calculated that the works would produce from 30 tons to 40 tons. The plant laid down was contemplated to produce 35 tons. He had every possible reason to believe that the initial difficulties having been overcome, the wire company, like the copper company, would more than realise all that had been predicted of it.

The report and accounts were afterwards adopted, and the meeting terminated with a vote of thanks to the Directors, proposed by **Mr. Hays.**

NEW COMPANIES REGISTERED.

African Transcontinental Telegraph Company, Limited.—Registered by Hollams, Sons, Coward, and Hawksley, Mincing-ane, E.C., with a capital of £140,000 in £1 shares. Object : To onstruct, or procure the construction of, telegraphs anywhere on he continent of Africa, and, generally, to carry on the business of telegraph, telephone, and electric light, heat, and power supply company in all its branches, and to manufacture and deal in electric apparatus of all kind. The first signatories are :

	Shares.
E M'Euan Smith, 253, Cromwell-road, S.W.	1
J. F. Jones, 25. Colfe-road, Forest Hill, S.E.	1
R. C. Bolton, Clifton House, Crouch End, N.	1
C. W. Chandler, 45, Hayter-road, Brixton, S.W.	1
A E. Jowett, 12, Camp-road, St. Albans, Herts	1
M. O'Shaughnessy, 33, Upper Kennington-lane, S.E.	1
E. Pryer, Claremont, Alston-road, High Barnet	1

Registered without articles of association.

Dalziel's Atlantic Telegram Company, Limited.—Registered by Burton, Yeates, and Hart, 2, Surrey-street, Thames-embankment, W.C., with a capital of £25,000 in £100 shares Object sufficiently indicated by the title. The first directors are D. Dalziel, W. C. Hallett, H V. Huggins, H. F. Jackson, and Major J. E. Jamieson. Qualification, £100. Remuneration: Ordinary directors, £100 per annum each ; chairman, £150 per annum and 10 per cent. of the surplus profits after payment of 10 per cent. dividend.

BUSINESS NOTES.

Great Northern Telegraph.—The receipts for the month of December were £20,800.

Bristol.—The tender of Messrs. Siemens Bros. for the mains for Bristol has been accepted.

Direct Spanish Company.—The receipts of this Company for December were £2,092, against £2,180.

West India and Panama Telegraph Company.—The receipts for the half-month ended December 31 were £2,708, against £2,371.

Telegraph Rates to Australia.—This week's *Gazette* contains a table of the revised rates for telegrams to Australia and New Zealand

St. Louis Electric Road.—The Bill for the St. Louis electric railroad for trains at speeds of 100 miles an hour, has been laid before the Congress Committee on Commerce.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,252.

Chelmsford —The Chelmsford Town Council seem satisfied with the electric light, for they have authorised another arc lamp near the Shire Hall, at the price of £22. 10s. per annum.

Derby.—The Derby Electric Lighting Committee have recommended the acceptance of the tender of Mr. Vernon, amounting to £6,324. 17s. 5d., for erecting the electric lighting premises.

Street Railway Gazette.—Owing to rapidly increasing business the offices of the *Street Railway Gazette* have been removed from 334, Dearborn-street, Chicago, to larger premises, 265, Dearborn-street.

Electricity Supply Corporation, Limited. —This Company notify that the 5 per cent. interest payable to debenture-holders on January 1 next will be payable at the Union Bank of London on presentation of the coupons.

Bath.—According to the inspector's report, 20 electric lamps at Bath had been out during the past three weeks for periods varying from half an hour to six hours. This was due to a failure in the mechanism in the early morning.

Canterbury.—We understand that the Brush Electric Engineering Company have accepted the terms upon which the Canterbury Town Council are disposed to make over the provisional order for the introduction of the electric light into Canterbury.

Kimberley Exhibition.—Among the awards granted at the Kimberley Exhibition, South Africa, was one of a silver medal to Messrs. Woodhouse and Rawson United, Limited, for electric light fittings, of which we understand they made a first-class display.

Dundee Docks.—The Works Committee of Dundee Harbour Board have remitted to the Urgency Committee for consideration the question of lighting the harbour and docks by electricity, and of procuring an electric car to run from the West Station to the cattle depôt.

Cologne.—We are glad to learn that the Cologne electric central station has been a great success, and the capacity of the station will be doubled. The plant was supplied by the Helios Company of Cologne-Ehrenfeld, and the new plant will be built by the same company.

Dudley.—The Dudley Streets and Gas Committee report that the town clerk had laid before the meeting an application from Messrs. Siemens Bros. and Co. to tender for the lighting of Dudley by electricity ; also a similar application by the Brush Electrical Engineering Company.

City and South London Railway Company.—The receipts for the week ending January 1 were £966, against £878 for the corresponding period of last year, or an increase of £88. The total receipts for 1892 show an increase of £2,215 over those for the corresponding period of 1891.

Nottingham.—The inhabitants of Nottingham cannot be reproached with not taking an interest in their large municipal undertakings. Every week sees some suggestion for the economical supply of electric light for the town, not the least reasonable being the utilisation of the waste heat of the gasworks to generate steam for the boilers.

East African Line.—The British East Africa Company's land telegraph line has been completed from Mombasa to Lamu and Witu, a distance of about 200 miles. Captain Dundas, R.N., made in October another trip of some 200 miles up the Juba river, trading and establishing friendly relations with the people.

Water-Tube Boilers.—An invention has been shown to us by Mr. Gabriel Zahikian, of 124, Chancery-lane, for water-tube boilers, the chief feature of which is to secure a spiral flow of water along the tubes so as to obtain better distribution. A considerable saving in economy and prevention of decay is claimed as being thus obtainable.

Runcorn —At the meeting of the Runcorn Commissioners this week Mr. E. Wynne Humphreys moved that it be an instruction to the General Purposes Committee to enquire as to the probable cost and practicability of securing an installation of the electric light for the public streets of Runcorn, and to report to the Board at the earliest opportunity.

Fleetwood.—The report of Mr. T. L. Miller, A.M.I.C.E., who was appointed by the Fleetwood Commissioners to report upon the various tenders for the supply of electric light, is expected to be ready early in January. It may not be long before Fleetwood will be able to boast of one of the finest promenades in the country lighted entirely by electricity.

Madras Tramway.—The Madras Tramway Company expects to begin work without further delay, the requisite capital being now nearly all subscribed. Mr. H. V. Falconer, superintending engineer of the Bombay Tramway Company, who has had 10 years' service in that company, has been appointed manager and chief engineer of the Madras Tramway Company.

Berlin Electric Railways.—The two schemes for electric railways in Berlin are standing still for the present. The overhead project on the plan adopted at Liverpool is promoted by Messrs. Siemens and Halske, while the Allgemeine Company propose the underground project similar to the South London line. It is thought nothing further will be done until an overhead experimental line has been built.

Bewdley.—On Monday the Bewdley Town Council decided to appoint a committee to consider and report upon the desirability of utilising the power of the Rivern Severn for electric lighting, and also for pumping water for domestic and street-watering purposes. There was some opposition to the proposal, and it was urged that it would entail vast expense to obtain electric power from the Severn. The committee, however, was appointed.

Scarborough.—The necessary steps towards securing the completion of the installation of the electric light into Scarborough are being pursued with all possible speed. A site has been decided upon for the erection of the works, the company having purchased two acres of land situated in Beaconsfield-street and Salisbury-street, off Seamer-road. The plans are being proceeded with, Messrs. Hall and Tugwell being the architects. An early installation of the light is assured.

Electric Light Pillars at Preston.—At the meeting of the Preston Town Council last week, Alderman Hibbert drew attention to the design of the electric lamp pillars that were being put down in Fishergate. He objected to the character of the castings and said they were not such as any municipality ought to be satisfied with. The thing was coarseness itself. Councillor Foster did not think it fair for Alderman Hibbert to condemn the casting. He saw no fault with the casting. The matter was left over.

Chelsea.—A provisional agreement has been entered into, subject to its confirmation by Parliament, by which the Chelsea Electricity Supply Company agree to sell and transfer to the Kensington and Knightsbridge Electric Lighting Company all the rights and powers obtained by them in 1889 for the electric lighting of South Kensington. The sum agreed to be paid by the Kensington and Knightsbridge Company for these rights is £7,000, and the transfer is to take place within one month after the agreement has received parliamentary confirmation.

Newark.—At the meeting of the Newark Sanitary Authority last Friday, Mr. W. E. Knight, a member of the Electric Lighting Committee, asked whether the borough surveyor had communicated with the electrical engineers as he was requested to, and if he had any information to give to the Authority. The Town Clerk said there was to be further information to be obtained as to the levels of the river. The Borough Surveyor replied that he had been waiting for Mr. Rofe, the water works engineer, for these levels, but if not forthcoming he would take them himself.

American Lamps.—An injunction has been granted in the United States Courts against the Sawyer-Mann Company, on the suit of the General Electric Company, with reference to the manufacture of electric lamps. The General Electric Company are thus put into full possession of the rights to stop all manufacture under their patents until they expire in a year or two, and it is possible they may exert the power to crush out, not only all opposition in lamp manufacture, but all other opposition, to establish a monopoly as gigantic as that of the Bell telephone. Meanwhile the issue of the non-infringing lamp of Westinghouse is awaited with the greatest interest.

Jamaica.—The Jamaica Electric Light and Power Company supply arc lights (1,300 c.p.), intermittent use 2s. per half night, and 3s. per night, or on "moon schedule" at £3 per month. For incandescent lamps the charge for installation is: plain cleated work, 12s. per lamp; concealed, or in mouldings, 30s. per lamp; switches, 5s. each; current, 1s. 3d. per supply unit, or at contract for use as required; houses, five to 10 lights, 4s. per 16-c.p. lamp, down to 30 lamps at 2s. each per month; hotels, 25 per cent. extra; saloons, until 11 p.m. 5s. per month; stores, until 8 p.m. 3s. 6d. per month; lamp renewals by the company for the first four months, afterwards 4s. each.

Hull.—A meeting of the Hull Corporation Electric Lighting Committee was held on Thursday last week, when arrangements were made for the formal opening of the central station on January 16th by the Mayor. In the evening the members of the Corporation and those who have been connected with the station since its inception will be received at the Town Hall by Dr. and Mrs. Holder. Mrs. Leak (wife of Alderman Leak, chairman of the Property Committee) and Mrs. Holder will turn on the switches, and a lecture with electrical experiments will be given. On the following day the Mayor will open an electrical exhibition to the public in the Sessions Court, Council-chamber, and library.

Santiago.—The following are the main conditions for the lighting of Santiago, Chili: The minimum number of incandescent lamps is 2,000 and of arcs 50. The tender must mention power of lamps and price to be charged. The number of lamps may be increased by the Council on the same prices. The place of erection to be regulated by the local authority. The lampposts to be of iron, on a design to be submitted. The lighting to be from dusk to sunrise, the hours of lighting to be defined in schedule. The contractor to pay a fine of ½f. per hour of each interruption of incandescent lamp, and of 50f per arc lamp. The distribution to be by underground cables, in troughs as approved by the Council.

Redruth.—The promoters of the Redruth Electric Lighting Company are sanguine of success, and have increased their own holdings. They have obtained very substantial support both from leading tradesmen and private individuals. A draft prospectus has been prepared, and the authorised prospectus will probably be issued to the public in a few days. The scheme, if sufficiently supported, will start on a satisfactory basis, and be economically worked. The directors, of whom three are provisionally appointed—Messrs. Tangye, Michell, and Tweedy—will take no remuneration whatever for their services until the company pays 5 per cent. to its shareholders, and the provisional manager, Mr. Ernest Tangye, will draw only a nominal salary until that result is assured.

Cheltenham.—The adjourned discussion of the Cheltenham Town Council on the report of the Electric Lighting Committee recommending the adoption of a scheme for the introduction of the high-tension system for private supply and deferring for the present the question of lighting the streets with electricity was resumed at the meeting of the Town Council on Monday by Mr. Waghorne, who moved an amendment referring the matter back to the committee, with a request that they should take further professional opinion upon the scheme recommended by the committee on the advice of Mr. Hall (borough surveyor) and Prof. Ayrton. A long discussion ensued. Mr. Norman, chairman of the committee, eventually accepted the amendment, which was agreed to.

Electric Light for the Poor.—The best-equipped model lodging-house for the poor in the world will be that which is about to be opened by the London County Council. They have spent nearly £17,000 on it, and it will provide for upwards of 300 lodgers, who will each pay fivepence for their nightly bed. It will have the luxury of electric light, heating by hot air, bathrooms and shower baths, perfect sanitary appliances, hot and cold water basins, a steam laundry, dining and recreation rooms, with a good library, and a cheap cookshop on the premises for those who do not care to be at the trouble of cooking their own provisions. Everything is being done to make the place cleanly, wholesome, and attractive, and there are not likely to be any lack of applications for accommodation in this little palace of the poor.

Dundee.—The Dundee Property Committee have agreed that the whole of the town buildings should be illuminated with electricity. In the course of the discussion it was suggested that the Parochial Board should take advantage of the illuminant for the part of the building occupied by their officials, but the committee refrained from making any recommendation on the subject. Mr. W. H. Brownlee, electrical engineer to the Gas Commission, attended, and, subject to the approval of that body, he was instructed to prepare specifications for the lighting of the buildings, so that tenders might be obtained without delay. In addition to the illumination of the town hall, burgh courtroom, committee-rooms, town clerk's office, and city chamberlain's office, it has been decided to light up the lobbies, staircases, as well as the piazza in front of the building.

Electric Lighting of Omnibuses.—The electric lights now fitted for the London General Omnibus Company are run by a battery weighing about 8lb., placed in a wooden box under one of the seats. The box is provided with two brass spring terminals, which make automatic contact with the battery when it is let down into the box. The lamp is of a special manufacture, and is made as small as possible to allow it being placed in the centre of the roof, and for the same reason the incandescent lamp is suspended horizontally instead of vertically. By this arrangement a maximum amount of light is obtained and risk of breakage is avoided. The batteries and lamps are made by the Bristol Electric Safety Lamp Works, 40, Great Smith-street, Westminster. About 70 'buses have been lighted for some months, and 140 will have been finished by the end of the year.

Edinburgh.—At the meeting of the Edinburgh and Leith Gas Commissioners, Mr. Kinloch Anderson mentioned that there was a decrease in the consumption of gas as compared with the same month last year. He referred to the use of incandescent gas burners in London, and said that as there was likely to be competition for illumination in the city, he thought the Gas Commissioners should wake up a bit and see if they could do something in the way of competing with the electric light. Many people would take the electric light for a better illuminant, but if they could give them gas—as he felt assured they could—which would give a light even better, and certainly at a little less cost, than the electric light, then they should endeavour to do so. He suggested that the matter be remitted to the Works Committee, along with the enquiries they were making as to the use of oil in connection with the manufacture of gas, to see whether any improvements could be made in respect of burners. This was done.

Taunton.—The report of the Government inspectors, Sir T. W. Blomefield and Major Cardew, on the electric lighting proposals at Taunton has been issued. It traverses the whole statements of the various witnesses called, and ends by the following sentences: "It does not appear to us that the purchase of the works of the company would preclude the Town Council from adopting Mr. Kapp's recommendations as to private lighting, if on further consideration they think the system advocated by him most suitable. They might still retain the existing system for street-lighting. We do not think we are called upon to express an opinion as to the desirability of the proposed purchase or to advise what system is best adapted to the requirements of the town. As, however, we consider that no sufficient reasons have been disclosed to justify us in advising the Board of Trade to refuse the application of the Town Council, we recommend that the license should be granted." The Board of Trade have adopted the recommendation, and propose to issue the license.

Cardiff.—The Local Government Board are being pressed to hold an enquiry immediately with reference to the electric lighting of Cardiff. The present proposal, on plans prepared by Mr. Massey and Mr. Harpur (borough engineer) is for a station at Canton Common, costing in all £32,500. Of this it is estimated that the high-tension and low-tension mains will together cost nearly £8,000; that the transformers, underground chambers, etc., will entail an expenditure of £2,000; the arc lights, lampposts, etc., over £3,000; the buildings, chimney (150ft. in height), offices, etc., £5,600; boilers, £2,500; engines, steam-pipes, condensers, £3,500; accessories, £5,000; site, £1,500; and railway siding and turntables, £400; while the figure quoted to cover contingencies is a round £1,000. This expenditure will cover the provision of spare pipes in all the streets through which the mains will be run, so as to obviate the taking up of pavements again when extensions are made. The buildings, as Mr. Massey recently informed the Council, will be twice, and the chimney five times, as large as at present required. Motive power will also be arranged for at reduced rates in the daytime.

Barnard Castle.—At the last meeting of the Barnard Castle Local Board, Mr. Smith referred to the subject of electric lighting. He said that at Okehampton and Lynmouth the new light had been satisfactorily introduced, at the latter place with such simplicity that a lad in corduroys could give all the attention that the machinery required. It was being used for workshops and domestic use alike. The electric light was a great success, and they would one day wonder how they had got on without it. With regard to his own works, he would continue to light by electricity, no matter what it cost It cost him simply nothing at all. They had a hundred candle-power for 4d. weekly. Mr. Barker said he thought the electric light could be produced at Barnard Castle a great deal cheaper than was imagined. Mr. Brass, on the contrary, said he had made enquiry at one of the largest works in Cleveland, and he found that the cost of the electric light was incomparably greater than that of gas. Mr. Dixon thought the discussion was premature. He moved that the report of the gentleman who had inspected the town with a view to the introduction of the electric light be obtained before the next meeting.

China.—In the matter of electricity, says the *Western Morning News*, China is going ahead. The wild dream—as it was once regarded –of lighting Canton and other cities of the Empire by electricity and of building electric railroads is likely to become a reality. For several months Toy Wing Sang, an enterprising Chinese, has been interested in the incorporation of a company of Chinese and American capitalists. He has now almost succeeded in his efforts, and 14,000,000dol., raised by American and Chinese moneyed men, will be invested in the enterprise. Sang is now in San Francisco, but will soon leave for China to attend to the shipping of a portion of the machinery which has been ordered. He has experienced heavy obstacles in interesting American capitalists in the stupendous enterprise, but a far greater obstacle was the opposition with which he met from the lower classes of his countrymen, caused by their animosity against anything savouring of progress. Considerable opposition was also met with in obtaining permission from the Chinese Government to build the plant. However, all obstacles have been overcome, and before many months Canton will have electric lights, electric cars, and perhaps a telephone system. Sang says that the Edison Company and several firms have been contracted with to supply the motors and wire. Five hundred thousand dollars have already been spent for machinery, and perhaps as much more will be invested as soon as the electric light is in full operation. A franchise for an electric railroad will be obtained if possible.

Brussels.—The following is a short description of the plant to be employed in the pioneer electric light station at Brussels, for which the contract between the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, and the town authorities is now signed. This contract has only been signed after a close examination, extending over a considerable time. The chief feature in the scheme lies in the plan of distribution, the cables throughout being insulated with vulcanised indiarubber, and run in separate cast iron pipes, this system being adopted in preference to others on account of immunity from possible breakdown and consequent high cost of maintenance—most essential points, which had the full consideration of the town authorities, who, fortunately, did not decide on the question of first cost alone—an example which could be followed with advantage by other wealthy towns that can obtain money at a cheap rate, and are willing to exercise some foresight in such an important matter. The station, when completed, will have six units of 500 h.p. each, any one unit, if required as a reserve, or for exceptional loads for a short time, being capable of working up to 625 h.p. The battery of accumulators will eventually be increased to 1,250 16-c.p. lamps normal load. The pioneer installation will be on the site of Eglise Ste.-Catherine, Place Ste.-Catherine, near the Boulevard Anspach—the church to be removed by February next. It consists of three boilers, safety multitubular, 226 square metres heating surface each, with pumps and economiser complete. Two horizontal compound condensing Sulzer type, by Carels, of Ghent, 500 h.p. effective, but each capable of working up to 625 h.p. effective, if required. Four slow-speed multipolar, with a rope drive, two to each engine. The switchboard is arranged for 24 circuits on the three-wire system, with feeding centres. Accumulators are used of 140 elements, special construction, with ample clearance for a normal load of 625 16-c.p. lamps, arranged for easy examination. As has been said, the distribution is that known as the three-wire: each cable insulated throughout with vulcanised indiarubber, and drawn into separate cast-iron pipes. Distributing-mains each side of road from centres, which are connected to central station by feeders and pilot wires. The installation is to be in complete working order by October next. The current will be sold by meter. The Silvertown Company are to work the station for two years, after delivery to the satisfaction of the town.

Yarmouth.—A correspondent, writing under the name of "Verax" to the Yarmouth papers, argues the cause against giving the electric lighting power to a local company, pointing out where this is now done the price is almost always the highest—viz., 8d. a unit—while in Bradford, where the Corporation work the station, it is only 5d. "The real scarecrow in the matter is the fear of increased taxation," continues the writer. "Mr. Preece recommended the first expenditure of £10,000, and Mr. Danby Palmer assures us that we are running the risk of increasing the rates by ninepence or a shilling. How this statement can well be borne out it is difficult to ascertain. The facts seem to be these, a penny rate will be quite sufficient to meet payments on interest and sinking fund. The street lamps required to replace the old ones will number 146. These at £14 each will cost £2,044. The interest and repayment of this will not mean more than ¼d. in the pound. Then comes the question of working the plant for the supply of light. I don't suppose the cost of this would be more than £1,500, for Mr. Preece estimates that £2,500 would be quite sufficient to supply the current for 10,000 lamps. Assuming then that £1,500 would meet the cost of working and maintenance, a very fair assumption, that sum would mean a rate of 2½d. in the pound. That, added to 1¼d. required for interest and sinking fund payments, will mean a total of 3¾d. But I have not yet taken into account the saving on street-lighting. Last year's gas account showed the street-lighting in the town to have cost over £2,000. So that here we have a saving to the rates of over 3d. in the pound, leaving less than ¾d. rate to be provided for by the profits on the supply of the electric current to business and private houses. How, then, unless I am grossly mistaken in my figures, can Mr. Danby Palmer suggest any such possible expenditure as to involve us in 'a 9d. or 1s. rate'? It is not truly a bogey which Mr. Palmer, upon due reflection, will not even believe in himself. It is a very easy and sometimes enticing thing to get up and make a startling statement, but not such an easy thing to prove it. Of course it will be said that Mr. Preece does not recommend the immediate lighting of the streets by electricity, but why should not the Corporation become its own customer, both in the streets and public buildings, and thus ensure little or no extra taxation? It is very well known that there are now several business firms ready to take the light whenever available, and these are more than likely to make good any deficit on the electric lighting account." Looking at the matter all round, he hopes the Corporation will follow their determination and keep the supply in their own hands, notwithstanding all ignorant protest.

Telephone Trunk-Line Messages.—Much interest has been aroused, says the *Yorkshire Post*, in commercial circles by the action of various chambers of commerce with reference to the proposals of the Government regarding telephone messages on trunk lines On and after January 1st the Post Office authorities are to take over the trunk-line business of the National Telephone Company, which is the largest holder of telephones in the kingdom, and will inaugurate a new system with regard to the use by the public of the trunk lines. The old arrangement of payment of a yearly rental will disappear, and over both Post Office trunk lines and trunk lines of the National Company, there will be substituted a payment for each conversation of three minutes' duration at a minimum charge of 3d. Where the distance exceeds 20 miles and is under 40 miles, the fee will be 6d., and there will be an additional charge of 6d. for every 40 miles or fraction thereof. Longer conversations can be obtained at 3d. for every multiple of three minutes for 20 miles, and 6d. where 40 miles is spoken over. This new arrangement is embodied in a Treasury minute dated May 23rd last. The object of the change, as set forth in the minute, is that it is impossible to continue the present system, under which the telegraph revenue is seriously suffering, whilst on the other hand the extension of telephones is checked in a manner which cannot be permanently maintained. The projected change was brought under the notice of the Associated Chambers of Commerce at their autumnal meeting at Newport by the Newport Chamber, and it was pointed out that the business of the commercial firms would be seriously hampered, and that a great amount of business would be seriously affected if the system of paying for each conversation were to be introduced. The Associated Chambers adopted a resolution condemning the policy notified, and the Executive Council of the association was requested to wait upon the Postmaster-General to request him to withdraw the proposals. A memorial which has been drafted points out that industrial centres allied by reciprocal interests as well as shipping ports adjacent to each other will be greatly harassed, and the undoubted advantages of the telephone diminished if the proposals are adopted. The memorial is now under the consideration of Sir Albert Rollit, president of the Associated Chambers, with a view to effective action being taken. It should be explained that local exchanges will not be interfered with. It is only trunk lines where the change is to be made. In order to protect themselves against loss, the Post Office authorities will require each user of trunk telephones to deposit in advance a sum of money considered equal to one month's use of telephone. This is a piece of red-tapeism to which commercial men much object. The Associated Chambers are not without hope of inducing the new Postmaster-General to reconsider the matter.

Brisbane.—The Brisbane Metropolitan Tramway Company have petitioned the Governor-in-Council to postpone the time limited by the Tramways Act for the compulsory purchase of the tramways by the Brisbane Municipal Council or other local authority from 14 to 25 years. Under the eighty-fourth section of the Tramways Act of 1882 it is provided that after the expiration of 14 years after the completion of the tramway constructed under the provisions of the Act the Municipal Council may purchase the tramway with its appurtenances subject to any mortgage existing thereon on giving the company six months' notice of their intention to do so. It is in view of their intention to substitute electricity for horse-power that the company have under the twelvth section of the Tramways Act of 1882 Amendment Act presented a petition to the Governor-in-Council for an extension of time. The petition was considered by the executive council last week and acceded to. It was also decided by the Cabinet to transfer the administration of the Tramways Act from the Minister for Works to the Minister for Railways. Under clause 3 of the Tramways Amending Act the Governor-in-Council has power to impose conditions with respect to the position of the wires of the electric tramways so as not to interfere with the working of the telegraph and telephone wires. The following conditions, which are based on those in force in the United States, have been recommended by the Postmaster-General, and have been approved: 1. Poles to be of suitable dimensions, and to be not less than 25ft. in height, and so placed as not to interfere with telegraph poles or wires. 2. Poles to be distant from one another not more than 130ft. 3. Supporting wires to be not less than 23ft. in height above the surface of the earth. 4. Conducting and trolley wires to be not less than 22ft. in height above the surface of the earth. 5. Conducting and trolley wires to be insulated in a suitable manner to the satisfaction of the Postmaster-General, and so as to prevent the current being conveyed to the non-conducting poles or wires. 6. Proper precautions must be observed to the satisfaction of the Postmaster-General to prevent the falling of wires or cords; also for protecting the trolley wires by steel guard wires running parallel to them, not less than 6in. away, as a precaution against accident from the falling of telegraph, telephone, or other wires. 7. Special arrangements approved by the Postmaster-General to be made at crossings. 8. A second or return wire to be provided instead of using the earth as a return circuit. 9. The conducting wire to be carried at the opposite side of the respective streets or roads to that on which the telegraph or telephone lines are placed. 10. Each section to be provided with automatic devices for switching-off at the power stations. According to private letters from Brisbane, the prospects for any extensive business developments are very bad. Trade is bad; wages have been reduced; thousands of small houses are empty; rents are reduced, and altogether there exists great depression in all directions.

Dundee and Electric Cars.—The *Dundee Weekly News* has the following: "In Dundee action has now been taken with the object of determining the value of electricity as a motive power for cars. At the last meeting of the Works Committee of the Harbour Trustees, it was remitted to the Urgency Committee to consider the advisableness of lighting the harbour and docks by electricity, and to report at the same time on the question of whether power might not also be afforded for an electric car. At the meeting of the Works Committee on the previous day, ex-Provost Brownlee, in the discussion on the tramway question, directed special attention to the power of electricity, his speech in favour of delaying an extension of the tramway lease being looked upon by some as a plea in favour of the introduction of accumulator electric cars. Since then, in anticipation of the question being definitely raised in the immediate future, members of the committee have been fortifying themselves with facts and figures bearing on the point. These are obtained chiefly from the experience of other large centres, and it is, therefore, interesting to see what is being done in other places. The balance-sheet issued for last year by the Birmingham Tramway Company, the most enterprising firm of the kind in the three kingdoms, brings some important facts to light. No fewer than four systems of haulage are in operation—steam, horse, cable, and electric—and the figures given show the financial result *of each. The* steam system yielded a net *profit of about 3d. per car mile,* or a total of about £18,000; the horse system a profit of 1¼d. per car mile; the cable system a profit of fully 6d. per car mile; and the electric system a loss of something over 2d. per car mile. With his varied experience to guide him, the managing director has recommended the Board to purchase over 30 locomotive engines for the traffic, thus showing that this mode of traction has been found on the whole to give the best results. Out West a very similar state of matters in regard to electricity as a motor for cars is found. According to the *American Street Railway Journal* for December, 1892, there are in New York fully 260 miles of line worked with 15,794 horses and 2,376 cars; 11½ miles operated by 65 cable cars, and 15 miles worked by 60 electric cars. From these figures it will be seen that the percentage of electric power on the tramways in New York is very small, and is apparently confined to outside portions of the city. In Washington there are 43½ miles of tramways operated by 73 electric motors; 22 miles of cable lines with 354 cars, and 49 miles worked by 1,108 horses and 236 cars. Here again the comparatively small number of electric cars points to these being confined to the outskirts of the city. Returning to London, it seems that electric cars were in operation there—at Barking and Croydon—where the accumulator system was in use, but these were abandoned last summer as unsatisfactory. There is in existence a company, styled the Electric Power Storage Company, 4, Great Winchester-street, London, which offers to undertake the maintenance and working of 'approved' tramways equipped with self-contained cars at rates from 55 to 66 per cent. of gross traffic receipts. It is, however, stipulated that there must not be fewer than 20 or 30 cars, so that negotiations could not be opened with Dundee, where daily there are only some 13 cars on the streets."

Ogmore Valley.—Until some three or four years ago the Ogmore Valley was in a state of darkness, the public streets and roads being entirely without light. The 108 paraffin lamps were provided by the Ogmore and Garw Local Board. This, however, proved unsatisfactory on windy nights; it was felt to be desirable that some better means of lighting should be provided. Accordingly a number of the principal tradesmen and residents met, a committee was appointed, and it was decided to call in the services of Mr. George Wilson, electrical engineer, Aberdare, to consult with, and to advise them as to the practicability of adopting the electric light. That gentleman visited the valley, and surveyed the water power available, and laid before the committee plans and estimates. It was decided to form a limited liability company, and apply to the Board of Trade for a seven years' license, to be followed by a provisional order before the expiration of that time. The Ogmore Valley Electric Light and Power Supply Company, Limited, was then formed, and was registered with a capital of £10,000 in 2,000 shares of £5 each. A license was obtained, and their consulting electrical engineer was asked to carry out the works for the company. This has now been done, and on the 19th inst. 144 public and a number of private lamps were lighted for the first time, to the entire satisfaction of the directors and shareholders present. The inhabitants of Nantymoel and Tynewydd assembled in the street and greeted the new light with great enthusiasm. The whole of the arrangements have been carefully carried out, and there has not been the slightest hitch since the current was turned on. The system adopted is low-pressure continuous-current; the supply cables and wires are overhead, and have a total length of 28 miles, covering six miles of streets and roads. They are divided into three circuits for each district, the public lamps being switched in and out from the central station. The district is divided into two equal parts, one central station being erected at Tynewydd and the other at Nantymoel. The motive power for each station is at present obtained from a 35-h.p. nominal compound undertype engine (the one at Nantymoel by Fowler and Co., of Leeds, and at Tynewydd by Robey and Co., of Lincoln). A further addition of motive power will be laid in during next year, consisting of two 40-h.p. Pelton wheels. The fall of water at both stations being about 300ft., when this is done there will be, if required, a total available horse-power of 100 at each station, which is sufficient for the supply of 2,000 60-watt lamps. Three 12,000-watt "Wilson" G type, compound-wound self-regulating dynamos, each having an output of 200 16-c.p. lamps, are provided for each station, one of which is held in reserve, and by means of an elaborate and substantial switching arrangement, any one of the dynamos can be immediately switched on to either of the two main circuits. The number of lamps proposed to be installed at present (including the 144 public) is about 700; the demand for private lights is exceedingly satisfactory, and will ensure the pecuniary success of the company. It has been left for the enterprising tradesmen of the Ogmore Valley to set an example in South Wales by being the first to carry out in this district anything like public and private lighting under the Board of Trade rules and regulations.

PROVISIONAL PATENTS, 1892.

DECEMBER 19.

23317. **Improvements in thermometers and electrical connections therewith.** George Higton, Imperial-chambers, Albert-street, Derby.

23321. **Heating liquids by electricity.** Leslie Bradley Miller and Maurice Walter Woods, 2, Gray's-inn-road, Holborn, London.

23352. **Improved electrically-operated locks.** Edward Daniel Taylor, Goldhawk-road, Shepherd's Bush, London.

23361. **Improvements in writing-telegraphic instruments.** Albrecht Heil, 323, High Holborn, London. (Complete specification.)

23370. **Improvements in incandescent electric lamps.** William Frederick Taylor and George Frederick Barnes, Boswell-court, Croydon.

23385. **Improvements in electricity meters.** Herbert Woodville Miller, 2, York-mansions, Earl's Court, London.

December 20.

23409. **Improvements in storage batteries.** George Arthur Washburn, 52, Chancery-lane, London. (Complete specification.)

23421. **Improvements in sockets for incandescent electric lamps.** Benjamin John Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Joseph Hutchinson, United States.) (Complete specification.)

23453. **Improved method and apparatus for regulating the speed or expenditure of power in vehicles propelled by electrical energy, in particular that supplied by accumulator batteries.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour le Travail Electrique des Métaux, France.)

23460. **Improvements in electromotors.** Harry Theo Barnett, 14, Narcissus-road, London.

23501. **Improvements in devices for electrically playing stringed musical instruments.** Henry Harris Lake, 45, Southampton-buildings, Chancery lane, London. (John Vose, United States.) (Complete specification.)

December 21.

23539. **Improvements in or in connection with dynamo-electric machinery.** Wilfrid L. Spence and D. Stewart and Co., Limited, the London-road Ironworks, Glasgow.

23579. **Improvements in electric incandescent lamps.** Albert Zobel and Fritz Buchmüller, 18, Buckingham-street, Strand, London.

December 22.

23658. **Improvements in the armouring, covering, or protecting of electrical cables and the like.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

23674. **Improvements in distributing electricity and means or apparatus for the purpose.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

72365. **Improvements in the construction and arrangement of switches for use in connection with electric generators, especially applicable to alternators and their exciters.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

December 23.

23678. **Improvements in electrical measuring instruments.** Robert Alfred Wormell, 61, Park-lane, Croydon.

23680. **Improvements in voltaic cells used as standards and for testing purposes.** Desmond Gerald FitzGerald, 94, Loughborough-road, Brixton, London.

23733. **Improvements in and apparatus for the manufacture of chlorine and alkali by electrolysis of compounds thereof and anodes to be employed therein.** Edwin Thorley Parker, 47, Lincoln's-inn-fields, London.

23750. **An improvement in plates for secondary batteries.** Arthur Hough, 24, Southampton-buildings, Chancery-lane, London.

December 24.

23773. **Improvements in electric smelting, and in furnaces therefor.** Regina Niewerth, 1, Quality-court, Chancery-lane, London.

23774. **Improvements connected with the obtainment of the electric arc for lighting and other purposes, and in apparatus therefor.** Regina Niewerth, 1, Quality-court, Chancery-lane, London.

23783. **Improved electric incandescent or glow lamp.** John Plummer, Colinton, Midlothian.

23805. **A new or improved automatic electric switching device for use with arc lamps.** Richard Bombe and Ferdinand Schuchhardt, 70, Wellington-street, Glasgow. (Complete specification.)

23824. **Improvements in electro-supporting combs for electric batteries.** Alfred Julius Boult, 323, High Holborn. (Mannheimer Gummi-Guttapercha and Asbestfabrik, Germany.)

December 27.

23861. **Improvements in switches and connections for electric circuits.** Thomas Cockerill, 70, Market-street, Manchester.

23892. **Improvements in multiple telephony and telegraphy.** Maurice Hutin and Maurice Leblanc, 28, Southampton-buildings, Chancery-lane, London.

23902. **Improvements in alternate-current motors.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

23906. **Improvements in incandescent lamps for electric lighting.** Frederick Herbert Prentiss, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23919. **Improvements in and relating to electrolytic apparatus.** Thomas Craney, 45, Southampton-buildings, Chancery-lane, London. *(Complete specification.)*

December 28.

23961. **Method of and apparatus for avoiding abnormal consumption of electric energy or overloading of the main current when starting alternating-current motors.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

23967. **Improvements relating to reflectors for electric arc lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Carl Coerper, Germany.) (Complete specification.)

December 29.

23985. **Improvements in telephonic transmitters.** Alexander Marr, 70, Market-street, Manchester.

23988. **Improvements in electric arc lamps.** John Main, 98, Barrington-road, Brixton, London.

24008. **Improvements relating to electric lamps, and to apparatus connected therewith.** Alfred Lyster Shepard, 8, West Kensington-gardens, London.

24009. **Improvements in the manufacture of pipes, or conduits for electric cables or other purposes, and in the means or apparatus employed therein.** George Crompton and James Chambers, 55, Chancery-lane, London.

December 30.

24071. **Improvements in the application of an electric current in the boiling or evaporating of solutions or liquids.** Emile Louis Constant Schiff, 55, Chancery-lane, London.

24088. **Improvements in or relating to dynamo-electric machines.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edmund Louis Zalinski, United States.)

24098. **Method of apparatus for starting non-synchronous single-phase alternating-current motors.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

24099. **Improvements in telegraphic communication between lightships and the shore.** John Brown and Robert Llewellyn Prutton, 54, Fleet-street, London.

December 31.

24122. **Improvements in electroliers, pendants, brackets, etc.** William Bowker, 270, St. Paul's-road, Preston.

24127. **Improvements in secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

24147. **An improved automatic circuit closer for telegraph keys.** Charles Warren-Bradford, Monument-chambers, King William-street, London. (Date applied for under Patents Act, 1883, Sec. 103, 31st May, 1892, being date of application in the United States.) (Complete specification.)

24159. **Improved apparatus for forming the conductors of incandescent electric lamps.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

SPECIFICATIONS PUBLISHED.

1891.

3738. **Electrolysing and bleaching.** Marx. (Second edition.)
18597. **Electrolysis.** Andreoli.
21363. **Electric Lift.** Peral.
22507. **Supports for telephone receiving instruments.** Fraser and Kelson.

1892.

1464. **Holders for incandescent electric lamps.** Jenner.
1552. **Telephone transmitters.** Goffin.
1637. **Telephones.** Anders and Köttgen.
2163. **Electric measuring apparatus.** Crompton.
16262. **Electrolytical decomposition of alkaline chlorides.** Faure.
16561. **Electric motors, etc.** Meston.
19146. **Electrical insulators.** Lake. (Johns-Pratt Co.)
19160. **Telephone receivers.** Thompson. (Benjamin.)
19602. **Electric switches.** Blackburn.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5½
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5 3	5½ 3½
London Electric Supply	5	⅞
Metropolitan Electric Supply	—	6¾
National Telephone	5	4¾
St. James'	—	8½
Swan United	3½	3½
Westminster Electric	—	6

NOTES.

Platinum.—The *Mining News* says that a new discovery of platinum and iridium is reported from the Mudgee district, New South Wales.

Magnetic Flux.—Herr Ernst Egger has a long article on magnetic flux in dynamos and motors in the *Elektrotechnische Zeitschrift* for January 6th.

Death.—Dr. Leigh Burton, the inventor of the electric heater that bears his name, died within a few days of the end of the year at Richmond, Virginia.

Lettuces by Electricity.—In a report to the Cornell University, Prof. L. H. Bailey firmly establishes the commercial value of the electric light for certain winter crops, especially for lettuce.

Conductor Network.—The current flow in a network of electric mains receives a graphical treatment by Herr Joseph Herzog, of Budapest, in the *Elektrotechnische Zeitschrift* of the 6th inst.

Liverpool Railway.—A trial trip of this important electrical undertaking was made on Saturday with complete success. The line will be formally opened on February 4 by Lord Salisbury.

Turntable.—An immense electric turntable for turning locomotives is being erected at the Chicago Exhibition, at first for use and afterwards for exhibition. It has a capacity of 100 tons, and is to be driven by a 30-h.p. Thomson-Houston motor.

Incandescent Street-Lighting.—Mr. Sydney F. Walker argues, in the *South Wales Daily News* for Tuesday, against the use of arc lamps for street-lighting in Cardiff, urging that the saving of £1,000 a year would be made by the use of large incandescent lamps for this purpose.

Monument to Gauss and Weber.—A committee has been formed at Göttingen to raise a monument in this town to the memories of Gauss and Weber. Subscriptions to this desirable end should be sent before April 1st, 1893, to Herr S. A. Banfrey, banker, at Göttingen, who is treasurer of the committee.

Local Telephone Exchanges. — A long correspondence has been proceeding in the *Western Morning News* from Mr. F. Dagger, who proposes establishing a private local telephone exchange in the three towns with twin-wire service, and a lower tariff than that given by the National Telephone Company.

Portsmouth.—The work in connection with the erection of the central station at Portsmouth is progressing. The engineers, Messrs. Waller and Manville, have given their certificate for work done, which proceeding, of course, gladdens the heart of the contractor, because it means that he has done his work well, and thus gets his cheque.

Railway Improvements.—The London and North-Western Railway Company are about to introduce magnificent third-class dining-room cars on their Scotch expresses. Let us hope they will have the last luxury of railway travelling—electric light. It will be the fault of the accumulator lamp people if this improvement is missed.

Searchlight. — The enormous searchlight made by Schuckerts for the Chicago Exhibition has a reflector 4ft. diameter; the illuminating power of the bare arc is 150,000 candles, and the beam when directed by the reflector, it is stated, has a power of 160,000,000 c.p. The rays can be seen 60 miles away, and can be turned so as to be directed upward.

Obituary.—The announcement is made of the death of Mr. W. Hellesen, of Copenhagen, inventor of the dry cell which has been so widely taken up by Messrs. Siemens. He had recently sent a new battery to the primary-battery competition inaugurated by the Italian paper *L'Elettricita* (which closed on January 1st), and was interested in other electrical inventions.

The Investor's Guide.—Where to place an investment safely and with profit is the question which constantly troubles the capitalist, small or large. Bismarck has come to the rescue, and by acts, instead of words, points out the way. His recent investments have been made, so we are told, in American street railways. Now there should be no doubt what to do.

Tramway Lamps.—Incandescent lamps of a special character are now made for electric railway lighting by the American General Electric Company. These lamps are designed so as not to break by the vibration. In the single-loop form the filament is anchored to the point of the lamp, while in the spiral form the filament is mad in three close spirals mounted on a long heavy glass centre, giving great steadiness of filament.

Rapid Postage.—A scheme is being carried out for rapid delivery of mail matter by electricity between New York and Brooklyn chief post offices. A rectangular tube with trolley and small cars inside is the chief feature of this project. Postmaster Wanamaker entered into an agreement to this effect on the 20th of last month with the Automatic Despatch Company, who agree to lay the lines, and work it for one year at their expense.

Presentation.—Mr. H. J. Vose, who has recently been appointed to the post of superintending engineer, Post Office Telegraphs, for the South Wales district, was on Thursday, the 5th inst., presented with a very handsome dining-room clock by his late colleagues of the engineer-in-chief's office, General Post Office. The presentation was made by Mr. J. Hookey, assistant engineer-in-chief, and Mr. Vose, in a few well-chosen words, thanked him and the donors generally for the gift.

Personal.—On the 23rd of November, at Sydney, New South Wales, Mr. Arthur C. F. Webb, of the Government telegraphs (third son of Mr. F. H. Webb, secretary of the Institution of Electrical Engineers), was married to Eva Florence, second daughter of Mr. E. C. Cracknell, chief of the department. A silver afternoon tea service was presented to the bride and bridegroom by the telegraph operators, and among the presents, which were very numerous, Mr. Webb also received a silver cigar case from the students of his electrical engineering class at the Sydney Technical College.

Society of Arts.—The course of Howard lectures, by Prof. W. Cawthorne Unwin, F.R.S., on "The Generation of Power at Central Stations, and its Distribution," will commence to-night at the society's rooms in the Adelphi. The course will consist of six lectures, to be delivered on Friday evenings from January 13 to February 17. The lecturer will deal with the commercially available sources of mechanical energy, and the method of distributing it, treating in the last three lectures the hydraulic distribution of power, the transmission of power by compressed air, and the distribution of mechanical energy by electricity.

French Telephones. — From the report of the Directeur-Général des Postes et Télégraphes on the telephonic service in France it appears that at the end of 1891 there were 112 town exchanges worked by the State, and 46 in construction. From 11,440 subscribers at the end of 1889 the number had risen to 18,191 by December 31, 1891, an increase of 59 per cent. in two years. They produced a total receipt of 5,574,891f. On the 1st of January, 1892, the telephonic circuits represented 4,587 kilometres of line, and 9,174 kilometres of wire. The public call-offices produced a revenue of 210,722f. in 1891, the charges being 5d. per five minutes in Paris and 2½d. in the country.

An Inventor In Prison.—An interesting episode in the life of the late Dr. Werner Siemens is related in the *Electrical World.* It seems that in 1840, while still in the Prussian artillery, he engaged in a duel as a second, and was sentenced to imprisonment. While thus confined, he occupied his time in experimenting, discovering the art of electroplating, his rights in which he sold to a Magdeburg jeweller for 40 louis d'or. He was interrupted in his scientific work by the announcement of a pardon, and begged to be allowed to remain and finish his investigation, but this application was regarded as a joke on the authorities, and he was summarily ejected at midnight.

Bressa Prize.—Under the will of Dr. Cesare Bressa a sum of money has been left to the Royal Academy of Sciences of Turin for the establishment of a prize, to be awarded from time to time for the best scientific work written or the most important discovery made during the preceding four years. A new term, dating from 1891 to 1894, is now in progress, and scientific men and inventors of all nationalities may compete. The amount of the prize, less income tax, is 10,416f. These who desire to compete must declare their intention of doing so within the time above-mentioned, by means of a letter addressed to the president of the academy, and must send the work they offer for adjudication, which must be printed, as manuscripts are not considered.

Prizes.—Among the prizes to be awarded by the French Académie des Sciences during the next year or two are the La Caze prize of 10,000f. (£400), open to all nationalities, to be awarded in 1893, for the work which has contributed the most to the progress of physics; the Arago gold medal, for a work or service rendered to science; the Jean Reynaud prize of 10,000f. for original work, awarded in 1896; Jerome Ponti prize, 3,000f., in 1894, to the author of a scientific work; D'Ormoy prize of 10,000f. for work on mathematics, pure or applied, to be given if occasion demands this year; Leconte prize of 50,000f., awarded in 1895 to the author of any capital discovery in mathematics, physics, chemistry, natural history, medical or physical science; Planté prize of 3,000f. for the most important work or invention in the domain of electricity.

Novel Mountain Railway.—According to a Vevey paper, a proposal is made to run an electric tramway along the new and picturesque route recently opened between Glion and Avants. The current will be supplied from Montreux. A still bolder scheme is also talked about, which would certainly be a novelty, and this is an aerial railway from Glion to Sonzier, of the same kind as proposed to the summit of Mount Pilatus. As, however, the distance along the ordinary routes would be too great, a railway would be made descending about one-third the height of the ravine above the gorge of Chauderon. A strong wire cable anchored to the rocks would connect the two sides, and on this it is proposed to run a car containing four or six persons. The current to work this car would be supplied by turbines driven by the overflow of the Sonzier reservoir.

Telegraphing at Sea.—The telephote, an instrument invented by Mr. C. V. Broughton, of Buffalo, by which vessels at sea can converse at long distances, has been placed on public exhibition, and is pronounced a success by experts. The instrument consists of a series of wires and electrical connections, operated by a keyboard, by which 106 incandescent lights are controlled and made to produce the signals of the Morse telegraph alphabet. The wires number over 5,000, and occupy a space of only 11in. by 12in. The dots of the telegraph characters are represented by two illuminated lamps, the spaces by 12 unilluminated lamps, and dashes by 12 illuminated lamps. The inventor claims that 32-c.p. lamps can be seen at a distance of 10 to 15 miles. Mr. Broughton has secured patents in America and Europe. A complete instrument will be built and placed at the disposal of the United States Government, to be exhibited on the model of the warship "Chicago" at the World's Fair.

Electric Fog Signal.—The following description is published of the electric signal for communicating to engine-drivers in a fog: "The signal consists of an electric gong fixed on the engine. On the weather-board of the latter is placed a dial containing a miniature signal with a movable arm, painted red. In the signal-box is a similar miniature signal, which works with the one on the engine. A galvanised iron pipe is laid by the side of the rail from the signal-box to 100 yards outside the distant signal. Thus in any weather the driver can tell how the main signals are—whether at 'danger' or 'all right.' A bronze wire brush is attached to the footboard of the engine, and when this brush comes in contact with the pipe it completes the circuit, rings the gong, and the arms of the miniature signals on the engine show the position of the main-line signals. The dial of the miniature signal on the engine shows a light when necessary." The Great Northern Railway Company are understood to state that the invention has been at work in a satisfactory manner for the last two years.

Lighthouse Telephones.—A public meeting was held at Ramsgate on Tuesday to urge the Government speedily to carried out the proposed electric communication between lightships and the shore to prevent such loss of life as resulted from the recent wreck of the "Dilsberg" on the Longsand. The Mayor of Ramsgate (Alderman W. P. Blackburn) presided, supported by Mr. E. J. Hobbs, the promoter of a scheme of electric communication with lightships. Mr. Hobbs proposed a resolution to the effect that the Government be petitioned to investigate the facts connected with the wreck of the "Dilsberg" on the Longsand on December 9 last, with a view to ascertaining whether the disaster might not have been averted had electric or telephonic communication, as experimentally provided in 1885 and 1886, now existed. The resolution was carried unanimously. After other speeches had been made, the Rev. T. Hancocks moved that the Government be requested to establish an effective system of telegraphic or telephonic communication between lightships, lighthouses, and the shore, that the loss of life and property at present existing might be prevented. This resolution was also adopted.

Coupling Alternators in Parallel.—The problem of coupling alternating generators in parallel has been the subject of research by two French investigators, M. Blondel and M. Boucherot. The researches of M. Boucherot are given in the form of a paper discussing the question mathematically, in *L'Industrie Electrique* for January 10. The author justifies by theory the conditions necessary for good working in parallel indicated by practice: large moments of inertia, independent engines, low interior resistance, and low coefficient of self-induction. This theory, mathematically complex, but simple in its results, justifies the easy coupling of alternators at low frequency. The conditions can be satisfied by reducing the apparent coefficient of self-induction of the alternators by means of condensers, but this method pointed out by M. Boucherot requires practical commercial condensers, a requirement hardly yet fulfilled. The compounding of alternators, as employed in the Thomson-Houston machines, by having two exciting currents, one constant and the other proportional to the output, is not dealt with by M. Boucherot. The record of investigations by M. Blondel on this important subject are promised for a later number.

Micanite.—A curiously-written article was read before the American Institute of Electrical Engineers for Mr. Charles W. Jefferson and Mr. Arthur H. Dyer on a substance they call micanite and its application to armature insulation. Traversing the list of various substances used as insulation, the history and properties of mica are discussed. Among the attempts to overcome the disadvantages of mica are those involving the use of pulverised mica mixed with cement, but as the cement can form paths for the current it is in no sense a mica insulator. The authors use the small waste mica plates in building up large plates of any size and shape by overlaying the slips attached by a suitable cement. At first this was done by girls at the rate of a cubic foot an hour each, but is now done by machines. Plates as large as a yard square can be built up, and as the plate consists of thicknesses of mica, and a straight line intersects numerous films, it is a true mica insulator. Curved specimen tubes and stamped forms are made. The material rings like metal, and may be treated as "insulating metal." Numerous tests under pressure, under influence of steam, and high-pressure electric currents show the value of the micanite. The best samples of micanite show approximately the same electrical resistance as the best India mica.

Electroculture.—A paper is given in the *Bulletin* of the Société Belge d'Electriciens by M. E. Lagrange on the subject of the influence of electricity on the growth of vegetables. M. Lagrange divided a plot of land into three parts, and planted the whole with potatoes. In the first plot he buried a plate of copper and a plate of zinc, a foot square, 26ft. apart, joining them by a wire carried on insulators strung on cross wires. The second was cultivated on the ordinary method. The third had a number of small pointed conductors buried to 6in. below the surface, and rising 18in. above it, connected to an underground network of galvanised wires. All plots were submitted to the same care, and were under the same conditions of soil, sun, and rain. The result was, that the first plot gave 60 kilogrammes of potatoes, the second 80 kilogrammes, and the third 103 kilogrammes. This showed that the current electricity had, if any, a bad effect on the crop, while the static electricity gave considerable increase. But M. Lagrange found that in the first plot, though the yield was less, the leaves appeared sooner, the plants were larger and more thickly leaved, from which he argued that for plant cultivation current electricity proved effective, but for root crops static electricity was to be preferred. The Botanical Gardens might do worse than perform regular experiments in this direction, as well as on the influence of electric light on the growth of plants.

Electric Anæsthesia.—Dr. Wm. F. Hutchinson, of Providence, has succeeded in obtaining local anæsthesia by electrical means. At first he used vibrating hammers to obtain the effect by percussion. After much experimentation, he constructed an induction apparatus, consisting of carefully-calculated coils and having a rheotome of phosphor-bronze ribbon that could be easily regulated. When set to give C major, representing 540 vibrations per second, marked anæsthesia was produced, though if more rapid the effect was lost. At A major, one minute produced numbness. An attempt was made to produce local absence of sensibility on a patient suffering from a felon on the forefinger. The finger was placed in a metal tube filled with sponge moistened with salt water. Starting with A and running up to G sharp, in three minutes sensibility was not diminished; but tuned to C major, sufficient anæsthesia was produced in three minutes to allow of incising the felon without pain. In a case of tic-doloureux, the rheotome being adjusted to C, the negative electrode was applied to the nape of the neck and the positive to the forearm, and in 10 minutes the pain had completely disappeared, the patient enjoying a sleep afterwards for the first time in two days. With the apparatus described, Dr. Hutchinson was able to produce local anæsthesia with ease over an area about 1in. greater than that of the electrode. The experiment should prove of the utmost value in surgical operations.

Electric Star Cluster.—The theatre is certainly the place where some of the most beautiful effects of electric lighting are to be seen, and a novel effect recently introduced into the pantomime of "Dick Whittington," at the New Olympic, London, bears the palm for delicate blending of beauty and science. The scene is the time-honoured, classical one of Highgate-hill, where the hero, Dick Whittington, goes to sleep to dream of success and hears the bells toll "Turn again." During this scene the stage gradually darkens, and a cloud-like screen in the background is seen to be lighted up by a multitude of tiny incandescent lamps, which sparkle and twinkle like veritable stars in the firmament. The screen is so arranged as to give a faithful representation of the celebrated star cluster in the constellation of Hercules, one of the most beautiful of the star clusters in the whole sky. To produce the effect, 400 incandescent lamps, run on 20 distinct circuits, are employed. All the circuits are joined to two massive copper conductors placed at the top of the screen, and each circuit is protected by an automatic cut-out. As each lamp requires fully half ampere to incandesce it, it follows that about 200 amperes are required to actuate all the lamps. For the desired variation in the brilliancy of these artificial stars, lamps of voltages varying from 3½ to 4½ volts are used. Collectively the light obtained is equal to about 150 c.p. The batteries for working this installation are placed on the stage, and are of the lithanode type. This original electric star group was designed and made for Mr. Oscar Barrett by the Lithanode and General Electric Company, of Westminster, who are certainly to be complimented on the beautiful effect produced.

Development of Gas-Engines. — The economical use of gas-engines for large powers threatens to develop into one of the most important problems in engineering, and especially electrical engineering. While Mr. Thwaite and Mr. Dowson have brought the question to the front in England, M. Witz has been calling the attention of French engineers, by a paper read before the Société Industrielle du Nord, to the latest and very remarkable progress achieved in this class of engine. In tests which he has carried out at Rouen two years ago, a 100-h.p gas-engine was found to consume 600 grammes of anthracite per effective horse-power hour. Nowadays this result is being obtained in commercial practice. The motors are not fed by the town gas, but a gazogene is added, which requires little attention, and the production of gas is regular and constant. This gazogene takes the place of the boiler. A poor quality of gas is utilised, giving about 1,500 calories per metre cube at 0deg. C., and 760mm. pressure. The process is not new, having been described by Thomas and Laurens in France, and Siemens in Germany, while heating gas is produced by Dowson, Lencauchez, and others, at a price very much less than was before possible. The efficiency of the gazogenes is as high as 80 per cent., when the best boilers do not rise over 70 per cent. Moreover,

M. Witz points out, the gas-engines give a gain of 28 per cent. in efficiency over the best-constructed steam-engine. From these results a total gain in efficiency, justifying the most brilliant hopes for the future of gas-engines. There are no doubt certain difficulties to be overcome before gas plant is as perfect as steam plant, but these are not insuperable, as the astonishing spread of the Crossley and other gas-engines amply proves. The tests show that in everyday practice a brake horse-power hour can be obtained for less than 600 grammes of anthracite; Crossley's have obtained the same result with 783 grammes of coke. The speed is sufficiently regular to drive dynamos satisfactorily. In conclusion, M. Witz states that gas-engine plants, provided with gazogenes, are spreading far and wide, and their progress is likely to lead to extremely important industrial results.

Heilmann Electric Locomotive.—It will be remembered that we described last year the proposal by M. Heilmann, engineer, of Paris, to run ordinary locomotives electrically. An electric locomotive on the Heilmann system is, it appears, now actually in an advanced stage of construction at the Forges et Chantiers de la Méditèrranée. M. Heilmann has recently described to the Société des Ingénieurs Civils the reasons which led him to believe that it was practically impossible to transform the ordinary railway lines into electric lines; electricity would allow of increase of speed, but apart from the great question of alteration of way, the speed is limited by the signals to be passed and the level crossings to be traversed. M. Heilmann has therefore designed a combined steam and electric locomotive as described in earlier articles, in which steam-boilers and engines are carried as now, but the actual traction work or rotation of axles is to be performed by motors mounted on the axles, either of the engine alone or of all the carriages. The reasons for the theoretical advantages have been explained — namely, that triple-expansion engines could be used; the difficulty of adapting crankshafts to act both rigidly for a reciprocating engine and yieldingly for a rotating rolling axle now limits the speed, besides the difficulty of getting rid of the exhaust steam; while with a constantly rotating motor on the axle these difficulties disappear, and greater speed and greater economy may be expected even with the slightly increased weight. The engine and generator are mounted on the front part of the locomotive. The engine is of the compound, balanced, horizontal type, made by Ch. Brown. The dynamo is a continuous multipolar dynamo, designed by C. E. L. Brown. It is excited separately by a small dynamo driven by a separate small engine. Behind is the boiler, Lentz system; the smoke-stack is in the rear, an arrangement which gives better draught. The motors are mounted on the axles by an elastic suspension. One of the principal advantages of the Heilmann locomotive is the independence of the speed of the train and that of the engine; this independence enables the engine to be run at constant admission, and consequently under the best economic conditions. The authorities of the French State Railways have put their lines at the disposal of M. Heilmann, and trial runs of the new locomotive may be expected shortly.

Coast Communication.—The following abstract of the interim report of the Royal Commission which has been taking evidence upon the question of improving the coast communication of the country, appears in the *Western Morning News*: "The report shows that with what has already been done, and what is now recommended, the Commissioners have practically met the demands which have been made by the Chambers of Commerce, Chambers of Shipping, the Lifeboat Institution, and by individuals for some years past. By what has been done already the Government have conceded the necessity, even while the Commission was pursuing its investigations of connecting lifeboat stations, coastguard stations, shore lighthouses, and rocket stations with a network of telegraph and telephone wires, which the reports of the Lifeboat Institution show, have already been instrumental in rescuing lives, and which will no doubt be often effectual in salving property, as well as useful in operations of war, whether mimic or real. The energy which the authorities and officials have displayed in giving effect to the recommendations of the House of Commons is illustrated by the fact that the sum of £20,000 provided last session for the work has just been expended, and that things must now remain at a standstill until the 31st of March next, when a new vote can be taken to supply fresh funds. In spite of the uncertainties of legislation, it is not likely that the House of Commons will hesitate to grant the comparatively small sum necessary to pursue a scheme which, even it is inception, has proved itself a most valuable means of aiding those who face the perils of navigating our dangerous coasts. In the recommendations which the Commission have now made in their interim report—which has not yet been published—they indicate their desire to see a very substantial experiment tried in connecting rock lighthouses and lightships with the shore by telegraph or telephone. By this means lifeboats may be summoned to vessels in distress, or a ship in imminent danger may be saved by the speedy arrival of a tug, which, without the lightning speed of the telegraph, could never have reached the spot in time to be of service. It is recommended that five lightships shall be connected with the coast, as well as a number of lighthouses, which seem to offer the best opportunities for testing the feasibility of the scheme as well as its value in the cause of humanity and the salvage of property.

Municipal Electric Lighting.—A pamphlet to guide municipalities in choosing their system of electric lighting is issued by the Brush Electrical Engineering Company. It has a delightful piece of artistic drawing to recommend it at first view on the title-page, showing the view of London up Ludgate-hill, with St. Paul's behind, and a view of the new arc lampposts now familiar in the City. This title-page to "Municipal Electric Lighting" is printed in bronze, and covers a useful digest of the salient points to be considered in town-lighting. Definitions in simple style are given, with everyday illustrations. A discussion of the parliamentary regulations follows. We entirely agree with the opinion expressed, that "on economic grounds it would appear wiser for municipalities to retain their powers in their own hands and establish their own central stations," on account of the many advantages of management and money they possess, and the desirability of working the light supply for the benefit of the public. The discussion of systems of supply is dealt with at some length. There is no "best system" for all conditions, and none is advocated; each area of supply must be considered on its merits. At the same time the advantages of the alternating-transformer system to which the company are partial are pressed home. The two objections—absence of storage and difficulty of the use of motors—are thus answered in this pamphlet: "As large users of secondary batteries, they (the Brush Company) have arrived at the expensive experience that however suitable and, indeed, indispensable accumulators may be for house-lighting, they are too costly for central-station work." The advantage as to certainty of running does not always lie, they say, on the side of storage-battery systems; for instance, one of these companies with which they are connected failed to keep a constant supply during the great fog simply from inability of the batteries to hold sufficient supply, while at Milan a constant supply without batteries has been given without break for nine years. The advantages of a battery supply are admitted for low-tension distribution, but the additional expense and complication must be always considered. As to the question of motors, the conclusion from the Brush Company's experience is that people like to talk about motors, but do not in practice show much inclination to use them. At the same time, alternate-current motors are perfectly able to be used, and in some cases, such as for the utilisation of Niagara and large water powers on the Alps, appear to be preferred, while small alternate-current motors for fans and so forth are already on the market. Some advice as to motive power for central stations is appended, preference being given to high-speed engines, followed by remarks on the use of steam-condensers. The price of street-lighting, and the charges to consumers are discussed, the whole making, as can be seen, an extremely welcome stock of information to the councilman or borough engineer.

The Pacific Cable Scheme.—The Canadian Government having decided to ask the Imperial authorities to appoint a commission to enquire into the feasibility of the scheme for a Pacific cable, a representative of Reuter's Agency called upon the various agents-general of the Australasian colonies to ascertain their views on the subject, and what support was likely to be forthcoming from their respective Governments in this connection. Sir Andrew Clarke, the acting agent-general for Victoria, said that if he had any voice in the matter he would strongly urge his Government not to entertain any idea of granting a subsidy for the purpose. From a strategical point of view the cable would have no importance whatever, and would be no practical help in time of war. The existing cables to Australia adequately carried all the traffic. He would favour the scheme, however, on the principle of favouring competition. Sir Saul Samuel, agent-general for New South Wales, preferred to express no opinion, as it was a matter for the consideration of his Government. Mr. Westby Perceval, agent-general for New Zealand, in discussing the scheme, stated that, although in receipt of no instructions from his Government, he would favour the proposal of an alternative cable to Great Britain which would run entirely through British territory. That he had always regarded as a matter of the utmost importance from a strategical point of view, and he was of opinion that his Government would be prepared to entertain favourably any proposal to join with the Australasian colonies with the object of establishing connection by post or telegraph with the mother country across Canada. He would, however, add that the present communication was sufficient for the traffic, and the cable rate had recently been reduced by nearly 50 per cent. by his colony joining in the cable guarantee with the other colonies. Sir James Garrick, agent-general for Queensland, believed his Government would look very favourably upon the scheme. Sir John Bray, agent-general for South Australia, on the other hand, expressed the opinion that most of the Australian Governments would not be prepared to go to any expense for an alternative cable, the existing one meeting all requirements. Sir Edward Braddon, agent-general for Tasmania, on being questioned, stated that he could not say what position his Government would take up in the matter. He would draw attention to the fact that New South Wales and Queensland had each agreed to subsidise, to the extent of £2,000 per annum, a cable to be laid by the Société Française des Télégraphes Sousmarins. This cable, which had been proposed to the Australian Governments by Mr. Audley Coote, M.L.C., of Tasmania, would start from Queensland *viâ* New Caledonia, and would, consequently, not be an Imperial line. It was stated that the French Government were willing to contribute £8,000 towards its construction; but this needed confirmation. Mr. Audley Coote also held a concession from the Queen of Hawaii.

Electric Construction Catalogue.—It is impossible, in presence of the very fine catalogue now issued by the Electric Construction Corporation, to avoid the reflection that here is a company which is capable of doing the largest and most important electrical engineering work, and of doing it well. A catalogue that produces this effect upon inspection has certainly succeeded in one of its aims; when the other aim—to give succinct and clear information as to details and prices in acceptable and accessible form—is added, as here, the Corporation are to be congratulated on having produced one of the most imposing works of this kind in the trade. The book is got up in the highest style, beautifully printed on the glossiest of paper, and if there is one thing to object to, it is simply that photographic process blocks will not come up to this extreme standard of excellence—nothing under first-class wood blocks could match the printing. There is no good reason why English catalogues should not rival those of American production, noted for their beauty of finish, and this attempt is certainly a long way in the right direction. The book commences with six fine full-page illustrations—first, the interior of a central station as erected by the Corporation, showing rows of alternators direct driven by triple-expansion engines; then the same thing applied to continuous-current station plant—all photographs from actual work done. A large electric car occupies the third plate, working on the closed-conduit system, while in the next an electric crane traversing a huge warehouse is seen in action. The photograph of a central-station switchboard occupies Plate V., and the sixth is a magnificent representation of a 450-h.p. Elwell-Parker dynamo for station lighting or transmission of power. After this are photogravures of the more ordinary kind of dynamo as used in smaller installations for running off shafting, or by gas or oil engines for lighting private houses or for factory lighting. The Elwell-Parker continuous-current dynamo used as a motor is recommended for power transmission—the number of watts given as a dynamo, divided by 900, gives the brake horse-power obtained, the speed being 15 per cent. less than that required to give the output as a dynamo. These dynamos are made in stock sizes from 800 up to 50,000 watts, at voltages of 50, 60, 80, 100, 135 volts. Depositing-dynamos at 4, 5, or 8 volts for nickel, silver, or gold deposition are shown, while for copper-depositing the machines rise to the highest size—the pair of machines illustrated, coupled on one bed-plate, being capable of depositing 30 tons of copper a week. The direct-current transformers which the Electric Construction Corporation have made a specialty in some systems of lighting, as, for instance, Oxford, naturally occupy a prominent position. The high-tension alternating system is illustrated in detail—Elwell-Parker alternators, transformers, fuses, and high-tension switches, and all the necessary paraphernalia for town-lighting. Some clear switchboard diagrams showing connections for accumulator installations are also added, and photographs of arc lamps conclude the volume. The catalogue bears a view of the Corporation's extensive works at Wolverhampton on its title-page, handsomely lettered in shaded red, and is altogether a speaking tribute to the vast and growing importance of the electric construction industry.

CENTRAL-STATION STATISTICS.

BY J. HESKETH.

There is no more important section of a central-station engineer's duty than to accurately keep and criticise his costs week by week. In a well-ordered station, not only will the engine and testroom have full attention, but the storeroom and clerks' office will be constantly under the engineer's supervision.

Too often in the statement of the cost of the production of electric energy we see engineers stating only their weekly coal, water, oil, and wages accounts. In many cases they are content to estimate the all-important factor of metered units from the apparent output of the station, making a certain percentage reduction for magnetising and leakage losses.

But for a correct and conscientious statement of a station's progress, it is obviously essential that all charges be included—whether they be office, management, works, or distribution charges—and that an accurate record be kept weekly, fortnightly, or, at the outside, monthly, of all meter readings. When the number of consumers has increased to such an extent as to make even monthly readings a difficulty, the engineer may then with safety resort to a primary wattmeter for a record of his output, and on the comparison of the records given by it with the quarterly readings of the consumers' meters, base his calculations of the various losses.

In drawing up the form in which these periodical cost-sheets are to be made, attention must, of course, be given to the form of accounts prescribed by the Board of Trade; but, as a general rule, a sheet somewhat on the following lines will be found to meet all requirements:

COST-SHEET FOR PERIOD ENDING ....

Total Metered Units.				
	£	s.	d.	Cost per metered unit.
GENERAL CHARGES:				
Directors' fees				
Consulting engineer				
Law expenses				
Accountancy expenses				
Bank expenses				
Depreciation				
Office and management salaries				
Office wages				
Rents, rates, and taxes				
Office sundries (stationery, etc.)				
STATION CHARGES:				
Salaries				
Wages				
Coal ....tons				
Water.........M. gallons				
Oil, waste, and petty stores				
REPAIRS:				
Boilers, steam, and water service				
Engines				
Dynamos				
Accumulators				
DISTRIBUTION CHARGES:				
Conduits (material and wages)				
Conductors (ditto)				
Meters (ditto)				
Transformers (ditto)				
Sundry apparatus (ditto)				
Total cost				
Average current				
Total units output				
Metered units as above				
Percentage of waste				
Number of 30-watt lamps fixed				
Maximum supply demanded				

It may be objected by some that many of these items can only be estimated. I think that with care they will all prove to be accurately arrived at. Directors', consulting engineer's, insurances, accountancy and law charges, are all most frequently fixed amounts.

The main source of error must arise from inaccurately-kept wages and stores records. Either the men do not send in a correctly-drawn time-sheet, or in the summary of the times spent on different works a system of sub-heads far too meagre is considered satisfactory; or when stores are required they are frequently drawn direct from the manufacturers to the work without passing through the store, and sometimes even without an official order.

It at once appears that it is of primary importance that each man, whether paid "salary" or "wages," should send in periodically an analysis, under carefully-drawn heads, of his works, and that all material be kept under a storekeeper's charge. But no well-regulated central station is without some such arrangement. It is a matter of detail to extend it, and for the storekeeper to periodically hand in his summary of material issued under the heads chargeable to revenue.

Further, with such a system it is almost a necessity for each issue of material to be properly authorised by the engineer responsible for the particular work on which it is to be used. The advantages of this are obvious. By this means the storekeeper is not only guarded and checked, but he is enabled to keeps books open to checks and comparison with his stocks at any moment.

The sheet may be amplified to give such further information as each engineer may desire. For instance, coal is stated in tons and water in gallons as well as in £. s. d. Allow for loss and water used for cleaning purposes, and the average evaporative efficiency is obtained, or pounds of water and coal per electrical horse-power at the consumers' terminals can be easily arrived at. If frequent diagrams are taken of the engine performances, the ratio $\frac{\text{I.H.P}}{\text{E.H.P.}}$ can be obtained.

In short, too much stress cannot be laid upon the importance of the many points elucidated by such a cost-sheet.

For further comparison each sheet should be so arranged that the total and average of any charge can be observed each week, and a comparison made with the corresponding period of the previous year.

The exchange of these periodical records between central-station engineers would lead to very beneficial results. The keeping of such returns accurately is, in my opinion, an exception at the present time, and where they are compiled there are no means of comparison with similar returns of other companies.

Might I suggest that a sort of circulating library of central-station records be adopted? Each engineer would week by week, or otherwise as arranged, prepare his cost-sheet in some such form as I have drafted. He would then circulate it among the members of this mutual aid society. Each might, if he thought necessary, take a copy and would forward the original to the next in turn. By this means a most valuable fund of information would be at the disposal of each engineer, from which he would be able to justify an extension or emendation of his own practice.

The same lack of system prevails generally in the returns of electric traction companies. One observes motor and line repairs lumped with station charges, and at the end of a year any abnormal cost in any department frequently capitalised, instead of being charged against revenue or a suspense account.

It is only by a careful, systematic, and frequent analysis of the actual cost of each separate department that the distribution of electricity from central stations, whether for power or lighting purposes, can ever be placed on a firm and proper financial basis.

MAINLY ABOUT TROLLEY WIRES.

BY FRANK B. LEA.

"*Quot homines, tot sententiæ,*" which is to say, different people have different ways of winding up an old year and letting in a new one. Some look upon this time, with no little reason, as a period when serious thought and sober congratulation may be advisable. Others again, it is whispered, regard with favour the wassail bowl, and become thereby less capable of duly appreciating the flux of time. A considerable number of engineers and other people interested in the progress of electric traction in this country are, however, declared to have combined on the 31st of last month in the enjoyment of both the above-named methods of speeding the parted year, the occasion being the formal opening of the South Staffordshire Tramway Company's electrical system.

Now, although a formal inauguration ceremony as a rule is nothing but a statement to the public that some enterprise has passed successfully through its experimental stages, and although the South Staffordshire electric tramway has been described at length quite recently in these pages, yet the occasion and the enterprise deserve to stand as a fitting theme for some few scattered remarks, more especially upon the methods of construction. The opinion expressed openly and freely by some well qualified to judge who were present at the recent ceremony, coincides with that given in this journal when the South Staffordshire Tramway Company's electric system was fully described, and, put briefly, amounts to this: that the method of construction adopted on this line goes much further than any other yet devised towards completely satisfying public requirements.

There is no doubt whatever that the freeborn Briton kicks strongly against the erection of overhead wires *along* his thoroughfares and highways—although by many prejudiced in favour of existing methods this feeling has been unduly exaggerated—and still more strongly does he express disapproval when it is proposed to put up a number of wires *across* the street. Indeed, if electric traction by means of overhead conductor wires were to depend solely upon the usual system employed in the United States, where poles are erected on both sides of the street, connected by span wires from which the trolley wire is hung, there would be but a sorrowful outlook for the electric traction man in this country. Of course the best and in every way most desirable plan to adopt for a double line is the system of centre poles erected in the space between the lines: a bracket on each side may then serve to carry the up and down line trolley wires, whilst the top of the pole can support an arc lamp just as well as an ornament. But these considerations are only for the happy people who have not merely to instal a system of electric traction, but are also required to put down a permanent way as well; in fact, to build a complete road. Our present lines are very much otherwise, and must be taken as we find them, to be altered at a minimum of expense.

Granted, then, that the plan of centre poles can only be used under exceptionally favourable circumstances, there comes the question of how best to erect the trolley wire so as to avoid the very objectionable network of overhead wires that seems essential to a double row of poles, one on each side of the street, with span wires connecting them crosswise. There are two great objections to the latter plan: First and foremost—as already pointed out—a strong antipathy exists amongst the public generally by reason of the "caged-in" feeling that is given from the erection of cross-wires at short distances apart, and at a comparatively low height above the street level. It may well be doubted—utilitarian as our age has become—whether any extensive scheme employing such a system would be successfully carried out or even publicly sanctioned, although the results in other respects were to prove all that could be wished.

The second and much more powerful objection is, however, the simple one of cost. Even though the individual poles of a single row upon one side of the street only (with bracket arms stretching out to any desired length over the roadway)—as in the South Staffordshire line—must be designed to undergo a different, and perhaps more severe, kind of stress than those of the double row, joined by span wires, yet this difference can certainly not counterbalance the actual saving in cost of practically one-half the number of poles. There is a further saving by the abolition of span wires and their attendant details.

Whilst endeavouring, however, to avoid all the objections to crossing the street with an overhead system, it might be said of the design in this particular instance that it hardly goes far enough, and probably the tramway company would find much less danger of the trolleys jumping off the wire if the bracket arms on the poles were longer than in many cases they are, notably at the turnouts. It is really too much to expect from any decent and self-respecting trolley pole and wheel that it shall always take a turn-out safely and without jumping off, especially with the pole at right angles to the car, and the speed anything up to 10 miles per hour. The extra cost involved by adding to the length and strength of the bracket at these points would be more than counterbalanced by avoiding the trouble and annoyance caused by the trolley jumping off. With the trolley pole more nearly parallel to the car, there would be less of the side strain that tends to throw off the wheel. It may seem hypercritical to advocate such a plan, by which the bracket arms do not stretch quite across the road, or, say, not more than half-way, whilst decrying the use of span wires much lighter in texture and appearance; but the difference between the two—æsthetic and sentimental—is quite enough to carry the point, more especially when the saving in cost enters into consideration.

In conclusion, it may be stated with great confidence that the plan of poles and overhead trolley wire or wires along one side only of the street, as now for the first time shown in successful working, bids fair to prove a way out of the numerous difficulties that so far have beset the reasonable progress of electric traction by any overhead-conductor system; and seeing that a method has been devised which fulfils most, if not all, requirements, tramway engineers and officials only need to be reminded of the well-worn couplet that says:

> "It is not wealth, nor rank, nor state,
> But get up and 'git' that makes men great,"

in order to cause a great deal more activity in electric traction work than has yet been evident.

EXPERIMENTS WITH HIGH-FREQUENCY ELECTRIC DISCHARGES.

BY A. A. CAMPBELL SWINTON.

The author has succeeded in passing through his body from hand to hand sufficient electricity to bring the filament of an ordinary 5-c.p. 100-volt incandescent lamp very nearly to full incandescence, or to bring the filament of a 32-c.p. 100-volt lamp to full redness. Practically no sensation was experienced.

The apparatus employed consisted of a large "Apps" induction coil capable of giving 10in. sparks, supplied with current through the ordinary vibrating contact-breaker, and a resistance consisting of eight 50-c.p. lamps in parallel, from a 105-volt continuous-current supply. To the positive and negative terminals of the secondary of the induction coil were connected respectively the inside and outside coatings of three half-gallon Leyden jars connected in parallel. The disruptive discharge of these jars across an air-gap of about ¼in. excited the primary of a simple form of high-frequency coil, similar to those employed by Mr. Tesla and Prof. Elihu Thomson. The secondary of this coil consisted of 500 turns of No. 26 S.W.G. cotton-covered wire wound on a paper tube. Outside this paper tube was a glass tube, upon which the primary, consisting of 10 turns of three No. 16 guttapercha-covered wires, in parallel were wound. The whole coil was immersed in rosin oil contained in a wooden trough. The ends of the secondary were connected through small glass tubes, also filled with oil, to brass balls.

On approaching the hand to one of the balls forming the terminal of the oil coil, sparks shoot out from the brush discharge which surrounds it. If the spark is taken on the skin a sharp prick is felt, but on approaching the terminal or touching it with a piece of metal grasped in the hand, or after grasping the terminal itself, practically no appreciable sensation is felt. If the terminal is grasped in this manner with the right hand, sparks will shoot out from the left hand, or indeed from any portion of the body, if brought into proximity with another person, a piece of metal, the gas or water-pipes, or any conducting body. In the experiments referred to, the incandescent lamp was hung by one terminal on a wire connected to earth, and connection was made between the other lamp terminal and the coil through the two arms and body by the right hand being brought into contact with one terminal of the oil coil, and a piece of metal grasped in the left hand being approached to the free terminal of the lamp. At the first approach the bulb of the lamp became filled with phosphorescent light, but on reducing the distance between the metal in the left hand and the free lamp terminal, sparks shot out between them, and the filament at once became incandescent; the incandescence increasing very nearly to the full normal amount when the piece of metal and the lamp terminal were finally brought into contact.

To produce a similar incandescence of the filament with continuous or alternating currents of ordinary frequency would require about one-fifth of an ampere, and at first sight it would seem that this quantity of current must pass through the arms and body of the operator.

It has been generally assumed that with high-frequency currents the current is rendered harmless by reason of the high frequency; in fact, that high frequency renders harmless to the human body currents of a strength that would be dangerous and painful, if not fatal, were the frequency lower. The author is inclined to think that another explanation is possible, and that the true fact is, not that high frequency renders harmless a given strength of current that with ordinary frequency would be harmful, but that with high frequency it is possible to obtain effects with exceedingly small currents, that with continuous and ordinary alternating currents can only be obtained by the use of much larger currents.

This hypothesis is probably applicable to many other high-frequency effects, but as applied to the above-mentioned experiment it is simply this. The lamp filament having a certain definite resistance, with continuous or alternating currents which pass uniformly, or nearly so, through the section of the filament, a certain amperage of current is necessary to produce the number of watts required to raise the filament to incandescence. With the high-frequency currents, on the other hand, as is well understood, the current travels chiefly on the outer surface of the filament, little or none passing through the central portion. The current is, in fact, merely skin-deep. The virtual resistance is therefore very high, as only an extremely small portion of the sectional area of the filament acts as a conductor. There is an ample sufficiency of volts, and though the current is very minute, there is a sufficient expenditure of watts to raise the filament to incandescence. The lamp, in fact, ceases to be a 100-volt lamp, and becomes, it may well be, a 100,000-volt lamp. As confirming this hypothesis, it should be mentioned that while the filament was incandescent sparks passed between the lamp terminals, which were at some distance apart, this being evidence that there was a difference of potential amounting at least to thousands of volts between the two ends of the filament.

Returning to the experiments, several other curious results were obtained. If instead of connecting the lamp to the coil through the human frame a wire was used, the filament became much brighter than in the previous experiment. In fact, it gave considerably above its normal candle-power. From this it was evident that the human body offered considerable opposition of some description to the passage of the electricity. In order to form some idea of the amount of the opposition, the body was again inserted in the circuit between the coil and the lamp as previously, and the thumbs of the two hands brought near together. Sparks about one quarter of an inch in length were found to pass between them, evidencing that the two hands of the operator had a difference of potential between them apparently equal to some thousands of volts. When the sparks passed between the hands, or when the wrists were brought into contact so, as it were, to short-circuit to some extent the resistance of the arms and the body, the filament became very appreciably brighter. It should be mentioned that when sparks were allowed to pass between the hands, very perceptible shocks were felt in the wrists.

Another experiment was to connect one lamp terminal by a wire to the coil, connect the other lamp terminal to earth, and short-circuit the lamp through the body by grasping the coil terminal with one hand and a piece of metal connected to earth with the other. The effect of so doing was to reduce the incandescence of the filament to rather less than one-half its normal amount, half of the available current going apparently through the lamp, the other half through the body.

With the lamp terminal connected to the coil, it was found unnecessary to connect the other lamp terminal to earth to produce incandescence, all that was necessary being to touch this lamp terminal with a piece of metal held in the hand. That the incandescence of the filament produced under these conditions was due to the electrostatic capacity of the operator, and not to his forming a connection to earth, was evidenced by the fact that it made no perceptible difference whether he stood on the floor or on an insulated stool.

In all the above experiments the second terminal of the oil coil was free and not connected to anything. It was, however, found that the effect of a second operator touching this terminal, or of connecting it by wire to earth, was to diminish the incandescence of the lamp filament. It was also found that the filament incandesced to a greater degree of brightness when connected, as above, between one terminal of the coil and earth than when it was directly connected between the two terminals of the coil. This seems to show that capacity has much to do with the results obtained.

It should also be mentioned that in some of the experiments there was a decided tendency for the filament to vibrate in unison with the contact-breaker of the induction coil. In fact, in some cases the amplitude of vibration was sufficient to cause the end of the filament to beat against the glass of the lamp bulb.

PROMINENT SUBJECTS.

BY M. VOLK.

It seems to me that one could not do better than at this point in the history of electrical development to consider some of the prominent subjects towards which great attention will be given in the immediate future. It is very singular that the early history of most of our great industries is wrapped in obscurity, and it rests with the workers at the end of the nineteenth century to extricate the history of the development of the applications of electricity from such a position, so that future historians may be able to trace exactly the various phases through which each branch of the industry has proceeded. For the sake of the future generations the history of the utilisation of Niagara should be complete, and it seems that this utilisation may possibly proceed on a much larger scale than the present scheme, and the transmission of the energy obtained to enormous distances be satisfactorily carried out by means of transformers. Another point of immense importance to which attention is being given is the utilisation of coal, and the now wasted dust at the pit's mouth, and the transmission of the energy so obtained to the great commercial centres. In all probability, if attempts in this direction are made, gas-engines of large power, as indicated by Mr. Thwaites, will be used instead of steam-engines. The latter for stationary purposes are doomed. The transmission of heating gas under pressure is also practicable for warming our houses and for cooking purposes, and this if used in combination with coke or anthracite would give the required cheerfulness so much thought of in an Englishman's house. In connection with warming, electricity will be cheap enough to use extensively all about our houses, the warmers being heated up during the day and storing a sufficient heat to keep up the required temperature after dark, when the current which has been used for heating purposes can then be used for lighting purposes. In this direction we may be able to equalise to a very large extent the load at the generating station. Storage batteries will develop so that the plates can be obtained at a moderate rate per ton, and they will be of a spongy nature so as to expose a large active surface in proportion to their weight. Their life will be unimportant, for they will be viewed as fuel, and the cost of production reduced to labour for remaking and the cost of carriage. To cart about tons of lead month after month, and to nurse them as carefully as wax dolls to get a few more days' life out of them, is nothing but waste, and the constant remaking will steady the labour at the works, and so still more reduce the cost of production. This will enable many a goods traffic tram line to pay its way very well, and will develop electric road vehicles enormously. Great improvements are to be expected in small motors, which should be fairly efficient, and then the almost untried field of driving tricycles and suchlike apparatus would be opened either by the aid of secondary batteries of improved type, which could be charged at most towns or villages on the road if required, or by the possible invention of a primary battery. These are some of the directions in which we may hope for immediate development.

Probably one of the most exciting periods in relation to telegraphy and telephony is about to open—the inauguration of war between the Post Office and the telephone companies. The Post Office will not buy the single-line overhead wire of the companies as it is worth nothing. The telephone will gradually, with the development of trunk lines, displace the telegraph for ordinary business work, and the metallic circuit system only will be used. If this is so, the Post Office will inevitably be compelled to account to the country for the depreciation in the telegraphs. It is their duty to see that nothing interferes with the nation's property which has been so heavily paid for, and which, if this contention is correct—viz., that telephony will increase and telegraphy decrease—means that the capital sunk in telegraphs is likely to be wholly lost.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VI.—OHM'S LAW AND THE ELECTRIC CIRCUIT.

(Continued from page 27.)

The preceding rule only applies to two resistances; beyond two, the rule is more complicated. Take a case of four unequal resistances, say, r_1, r_2, r_3, r_4, we have—

$$\frac{1}{\mathrm{R}} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4}$$

$$= \frac{(r_2 r_3 r_4) + (r_1 r_3 r_4) + (r_1 r_2 r_4) + (r_1 r_2 r_3)}{r_1 r_2 r_3 r_4}.$$

$$\text{Therefore, } \mathrm{R} = \frac{r_1 r_2 r_3 r_4}{(r_2 r_3 r_4) + (r_1 r_3 r_4) + (r_1 r_2 r_4) + (r_1 r_2 r_3)};$$

this signifies that the combined resistance is in the form of a fraction whose numerator is the product of all the resistances, and whose denominator consists of as many expressions as there are resistances, each expression being obtained by dividing the product or the numerator by a different resistance. Putting $r_1 = 5$, $r_2 = 6$, $r_3 = 7$, $r_4 = 8$, we shall obtain a combined or equivalent resistance of

$$\mathrm{R} = \frac{5 \times 6 \times 7 \times 8}{(6 \times 7 \times 8) + (5 \times 7 \times 8) + (5 \times 6 \times 8) + (5 \times 6 \times 7)}$$

$$= \frac{1{,}680}{1{,}066} = 1{\cdot}57 \text{ ohms.}$$

Coming to the matter of division of current in parallel paths of unequal resistance, the current divides itself according to the conductivity of the path, or inversely to the resistance. In the example worked out, where the resistance of c is 15 ohms, and that of d is 20 ohms, let the current be 35 amperes at the point P. The conductivity of $c = \frac{1}{15}$, that of $d = \frac{1}{20}$. The whole of the current, or 35 amperes, passes through the two paths, c and d, and hence through the combined conductivity $\frac{1}{15} + \frac{1}{20}$. The current divides according to the conductivity; therefore, as the whole current is to the combined conductivity so the current in c will be to the conductivity of c.

Hence current in $c = 35 \times \frac{1}{15} \div (\frac{1}{15} + \frac{1}{20}) = 20$ amperes.

" " $d = 35 \times \frac{1}{20} \div (\frac{1}{15} + \frac{1}{20}) = 15$ amperes.

Where the number of paths in parallel are more than two, the current for any particular path is obtained by dividing the total current by the combined conductivity of all the paths, and then multiplying by the conductivity of the path in question.

Fig. 9 illustrates a circuit having some resistances in parallel and some in series. Let $a = 10$ ohms, $b = 10$ ohms, $c = 6$ ohms, $d = 7$ ohms, $e = 5$ ohms, and $f = 5$ ohms.

It is necessary first to eliminate out the combined resistance of the divided path, which will be $\frac{6 \times 7}{6 + 7} = \frac{42}{13} = 3{\cdot}23$ ohms. Substituting this value for the divided paths, c and d, we have now got all the resistances in series, and these have simply to be added up for the total resistance between terminals T and T_1; hence the total resistance $= 10 + 5 + 3{\cdot}23 + 5 + 10 = 33{\cdot}23$ ohms.

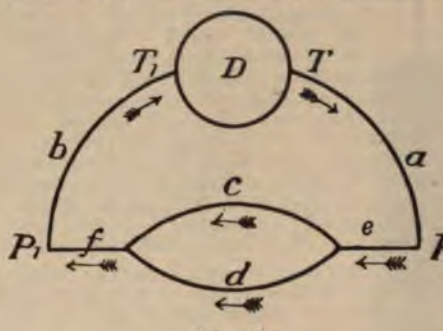

FIG. 9.

VII.—THE DYNAMO.

Magnets and Magnetism.—The fundamental principle upon which may be based the action of all dynamo-electric machinery was stated in the opening paragraphs; for convenience these remarks are repeated, which are to the effect that "if a length of wire or metal conductor, whose two ends are joined, so as to make a complete circuit, be caused to move across the magnetic field so as to cut through, so to speak, the 'lines of force,' then a current of electricity will be generated in that conductor, and will last so long as the movement of the conductor lasts in the magnetic field. The same effect will be produced if the wire is stationary, and the magnet be caused to move." Hence the presence of magnetism is necessary in those machines in order to produce an electric current, so before entering upon the province of the dynamo some elementary information concerning magnetism and its laws will be given.

Magnets may be classed in two divisions: (1) natural magnets; (2) artificial magnets.

The earliest knowledge we have respecting the curious phenomenon of magnetic attraction, is probably that regarding the properties of a certain earthy stone. This peculiar stone possesses the property of attracting iron, and was named a "lodestone" or "magnet," its attractive virtue being termed "magnetism." The lodestone is a natural magnet, and the earth is a huge natural magnet, the true or magnetic north pole being to the west of the geographical north pole, and the true or magnetic south pole being to the east of the geographical south pole.

Earth-currents seem to be the cause of the magnetic storms and disturbances that take place around the earth. As an example of the effect of unequal or different electrical conditions existing between the atmosphere and the earth, the aurora borealis may be mentioned.

Artificial magnets may be divided into two kinds: (*a*) permanent magnets; (*b*) electromagnets.

If a piece of steel be rubbed by a piece of lodestone, the steel is at once endowed with magnetism, and the harder the steel is the longer it takes to impart magnetism; but against this can be put a longer period of retention of magnetism. These magnets are named "permanent magnets," because they retain their magnetism for years. Soft iron cannot be made into a permanent magnet, although after being subjected to magnetic influences it will always retain a feeble and insignificant amount of magnetism too weak to have much attractive power. Electromagnets are made by passing a current of electricity a number of times around a bar of soft iron, so that the bar must be wound with an insulated wire. When the current is sent through these coils the bar is magnetised, but when the current is stopped the bar loses all its magnetism. Some of the early dynamos were built with permanent steel magnets; now, only electromagnets of wrought or cast iron are used.

When a current of electricity flows through a conductor, it is encircled by "magnetic whirls," or "lines of force," as shown in Fig. 10 and also in Fig. 11. These whirls are seen to be at right angles to the length of the conductor; hence, at right angles, or perpendicular to the flow of current in the conductor. If the conductor be coiled into a circle, this circle will embrace a great number of short lengths or parts of curved lines forming the magnetic whirls; and since the magnetic whirls become less dense the more they are distant from the conducting wire, therefore the lines that pass through the central parts of the circular coil will be less dense than those that pass through close by the periphery of the circular coil. Let the conductor be coiled twice round, the respective magnetic whirls of each turn would merge together in some parts and neutralise each other in other parts, and so form one larger whirl or loop of force, surrounding both the turns. Increase the turns to a considerable number, by winding the conductor in the form of a helix, or spiral, the turns being close together, and parallel with each other as much as possible, coincidental whirls will then merge together and form one large whirl or line of force, which will surround the helix, as shown by any of the dotted lines in Fig. 12, where, owing to the length of the helix, the lines of force map out practically a straight path along the length of the helix. We have thus the whole of the hollow space inside the helix threaded by lines of force, which curve round at one end, flow along the outside of the helix and enter again at the other end, thus forming a complete circuit. The direction in which these lines of force may be said to flow depends on the direction of the current that flows in the coils. When a flow of lines of force is spoken of, it must be remembered that the term lines of force is only a figurative expression illustrative of the path along which magnetic force tends to act, so that direction of flow may be taken to signify direction of force. A line of force always flows in a closed circuit in the same way that a current can only flow when there is a closed circuit; consequently, every line of force that issues from any part of an electromagnet describes a more or less symmetrical circuit (according to surrounding bodies) whatever extent of space it may have to travel through, and so return to the point from which we trace its departure.

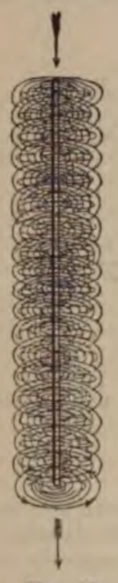

FIG. 10.

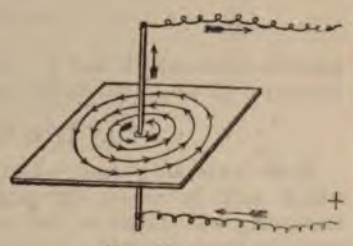

FIG. 11.

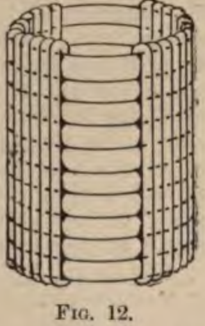

FIG. 12.

Any space through which lines of force pass is termed a magnetic field, therefore a magnetic field surrounds a wire carrying a current, and a magnetic field exists both inside and around of a helix of wire. Such a helix through which a current flows is technically called a "solenoid," the insulated wire forming the helix being usually wound on a brass bobbin, resembling somewhat a cotton-reel in shape, the channel formed by the flanges being filled with insulated wire.

The strength or intensity of a magnetic field at any point is denoted by the number of lines of force that thread through one square centimetre (·155 square inch) of area of the air, measured at right angles to the direction of flow. Thus if the internal diameter of a solenoid were 10cm., and there were 4,000 lines passing through, then the density, or the number per square centimetre, would be the total number of lines divided by the area in square centimetres, or 4,000 ÷ 78·54 = 51 nearly. So that the strength of field is 51.

Upon introducing a bar of soft iron just within the hollow of the solenoid, it will be sucked up with force and held there in suspension. This is due to the fact that the mass of iron is brought within the attractive range of the lines of force constituting the magnetic field, and therefore it is attracted; but whilst the iron bar fills up, or partly fills up, the hollow of the solenoid, a great change is made in the magnetic field. This change is that the iron has a far greater conducting power for magnetic lines than the air. Consequently, a far greater number will now flow through the mass of iron than what previously flowed through the space occupied by the air. It is this flow of lines through the iron that converts the iron into a magnet, and so the reason is explained why a piece of iron is magnetised by winding it with an insulated wire through which a current is passed, because putting an iron bar inside the hollow of a solenoid has the same effect as winding the bar with wire. When used as a solenoid, the bobbin carrying the wire is fixed, whilst the iron bar is supported, so as to be perfectly free to move up and down within the solenoid; when used as an electromagnet, the bobbin of wire and the iron core are both fastened together and stationary.

Solenoids are used when a long range of pull is required, say several inches, but this extended pull is only comparatively weak.

Electromagnets are used when a very powerful pull is desired, but this pull can only be exerted over a very short distance, measured in fractions of an inch. In the first case the mechanism to be moved is fixed to the free iron bar, or "plunger," as it is called; in the second case, the mechanism is fixed to an iron mass, called the "armature," placed a very short distance away from the end or pole of the electromagnet. The electromagnet attracting the armature moves the mechanism.

Magnetic Properties of Iron.—We have every reason to think that all matter with which we are acquainted, of whatever kind, is susceptible to magnetism; by the word "susceptible" we wish to imply "capable of being magnetised." With the exception of several bodies, all the rest are susceptible to so minute a degree that it is practically negligible, and hence they may be termed non-magnetic bodies, in order to distinguish them from those few which have marked susceptibility, and which may be termed "magnetic bodies." The non-magnetic bodies are very nearly equal so far as we can judge, and the air is taken as unity. Classed among these are a few bodies with a susceptibility less than air; these are named dia-magnetic bodies, but the strongest of them, which is bismuth, has a value of ·999 that of air.

The chief magnetic bodies are iron, nickel, and cobalt; the two latter are about equal, but iron is at least three times as susceptible.

Iron may thus be said to stand out alone, by being so much beyond all other bodies in respect of susceptibility.

Indeed, for the magnetic circuit, and for all apparatus receiving magnetic induction, iron—whether wrought iron, cast iron, or steel—occupies the same position as copper does for the electric circuit. This being so, the phenomenon of magnetism and its effects on bodies will be confined to iron, because it is only iron that will be dealt with.

(To be continued.)

LONDON INSTITUTION.

Dr. Silvanus P. Thompson gave the first of a series of three lectures on electric lighting before the London Institution last night, the subject of this lecture being that of dynamo machines. In a wonderfully lucid manner, of which Dr. Thompson has the complete gift, the development of the dynamo from small beginnings to the present huge central station machines, was gone through. It is difficult to realise that, in reality, it was not until the end of the last century that any other method of generating electricity was known, except that of the old friction machine. The magic of Volta's discovery is only so far from us as one century, yet exactly in 1800 Sir Humphry Davy produced bright sparks from Volta's coil, and two years after, in 1802, the arc light itself. It is interesting to learn that even in this year the conjurers had got hold of the new wonder, and in Paris, Robertson, a French predecessor of Houdin, announced "a light exceeding that of the sun produced between two ardent carbons." Grove, a member of the London Institution, first rendered the light possible in any practical manner by his battery ; but for the mechanical method now used we have the momentous invention of Faraday in 1831. Dr. Thompson described and illustrated the early forms resulting from Faraday's discovery. Clarke, Woolrich (the first commercial magneto machine), and Wilde, giving due praise to Hjorth, who was the first to introduce coiled windings of electromagnets into the apparatus. Holmes, in the exhibition of 1862, had a large magneto machine driven by an engine, upon which Faraday made a report 31 years after his discovery, with the remark that "his baby had now grown to a giant." This giant had grown still more in the next 31 years to 1893 ; and the names of Wheatstone, Siemens, Varley, and Ladd were those who simultaneously made the discovery which has led to the further progress in the self-exciting power of the dynamo. The discovery of Paccinotti and Gramme of the ring armature was described—one of the most important of the series of progressive steps in the development of the modern dynamo. Crompton was one of the early workers who had done much to improve the mechanical construction of the Gramme ring. Weston, in America, introduced the thin plates now general for cores, and Edison, after trying long thin poles for his magnets, produced the huge machines, which Hopkinson finally settled into the shape we know so well for low-tension work. In alternate-current machines the lecturer showed a working model made by Ferranti which lighted an ordinary incandescent lamp with ease. The types of machines developed by Siemens, Gordon, Mordey, Westinghouse, Kapp, and Ferranti were shown on lantern slides. Some interiors of the central stations were then described. It is suggestive to hark back to the old idea of Edison of a vast array of dynamos with long field magnets, looking like an Alpine fir forest, as a proposed typical central station, with some miles of belting. This "fondness for leather" is still a feature of American practice as compared with English station work ; belts everywhere—to drive dynamos grouped in rows, above or below the engines. The one example of American practice in England is the Sardinia-street station, where leather in conspicuous, but in the English practice we find either rope-gearing for very heavy dynamos, such as Ferranti's and the Brush engines at Bath and the City of London installation at Bankside, or else preferably direct-driven dynamos with economical triple-expansion engines, as at St. Pancras and elsewhere. The lecture was listened to with great interest by a large audience, the theatre being crowded. The second lecture next Thursday, at 6 p.m., will be on the subject of lamps.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 12.

Prof. Ayrton, Past President, in the chair.

Under ordinary circumstances the new president, Mr. W. H. Preece, F.R.S., would have given his inaugural address, but he is absent from England. Thus, after the usual formal business of reading and signing the minutes, the following gentlemen were balloted for and elected :

Member.—Harold Sherwin Holt, Oaklands, Teddington.

Associates.—James Bell, Postal Telegraphs, Dundee ; Prof. W. H. Bragg, M.A., Cantab, Adelaide, South Australia ; Joseph Bevan Braithwaite, jun., 18, Highbury New-park, N.; William Fredk. Burton, 10, John-street, Mayfair, W.; Alexander Cook, 30, Lancaster-park, Richmond, Surrey ; Edwin Philpot Crowther, 19, Central-road, Withington, Manchester ; Thomas Devitt, Eastern Telegraph Company, Malta ; Reginald Sydney Downe, the Electrical, Standardising, Testing, and Training Institution, Faraday House, Charing Cross-road, W.C.; Robert James Elmhirst, Stairfoot, Barnsley ; Clinton Coleridge Farr, B.Sc., St. Paul's College, Sydney, New South Wales ; Robert Gibson, Eastern Telegraph Company, Malta ; Samuel Henry Gowdy, 5, Bentinck-villas, Newcastle-on-Tyne ; Charles Henry Hill, Bedford-hill, Balham, S.E. ; Edwin Human, 8, Prince's-street, Westminster, S.W.; Robert Reid, superintendent of the Ferro-Carril Ingles, Lima, Peru ; Frederick William Reynolds, Bromley, Kent ; John B. Saunders, jun., Oriental Telephone Company Singapore ; Edward Carstensen de Segundo 28, Victoria-street, S.W.; F. C. Sinclair, 3, Hanover-terrace, Regent's Park, N.W.; James B. Smith, Central and South American Telegraph Company, Iquique, South America ; Samuel Spencer, A.I.C.E., Globe Tube Works, Wednesbury ; Robert Sykes, Northern Telegraph Works, Halifax.

Students.—Joseph H. D. Brearley, 41, Darghan-street, Glebe Point, Sydney, New South Wales ; A. C. Cormack, Strathleven-place, Dumbarton ; Robert Arthur Fullerton, 34, Agate-road, The Grove, Hammersmith ; Frank Hewer, 25, Connaught-road, Harlesden, N.W.; Henry Cook Leake, 76, Comeragh-road, West Kensington : Joseph McMahon, 195, Clapham-road, S.W.; Christopher Mark Mayson, 71, Vincent-square, Westminster, S.W.; Arthur Cecil Herbert Orpen, 23, York-road, Acton, W.; C. G. Paget, 91, London-road, Croyden ; G. F. Pilditch, Cambridge House, Cambridge-road, Battersea Park ; Chas. Henry Prichard, 24, Hazlitt-road, West Kensington Park, W. ; Albert Edward Robinson, Athole Lodge, Bush Hill Park, Enfield ; Hugh Innes Rogers, Raggleswood, Chislehurst ; Philip James Watts, 6, Gascony-avenue, West Hampstead, N.W.

The discussion on Prof. Fleming's paper was resumed by

Prof. Fitzgerald, F.R.S., who referred to some correspondence between him and Prof. Ayrton on eddy currents in transformers. It there seemed that attention had not been sufficiently called to a warning of Lord Kelvin to the eddy currents in the thick wire. The large coils were masses of unstranded copper, in which eddy currents might be set up, and such copper should be stranded. Copper on the outside of iron ring or cylinder had no eddy currents, but copper inside would have eddy currents induced. When the magnetic circuit was perfect, no importance was attached to thick wires outside the circuit; there would be no eddy in them. Prof. Fitzgerald explained that if lines of force existed within the metal, there would then be eddy currents. The important question was whether the thick coils should be outside or inside. On the whole, the speaker thought that the *driving* circuit, whichever it was, should be on the inside, where the eddying effect would be least. The position of the thick coil would thus depend upon whether they were transforming upwards or downwards. When there was leakage the density of the lines of force was greater near the iron than away from it, hence the thick wire should under these conditions be on the outside, but then they had more copper in which there was eddying effect, and they might ask whether that increased the heat. Still, though the question was not yet solvable, it was on the whole better to have the thick copper outside. Prof. Fitzgerald then called attention to the action in and around a closed magnetic circuit, and pointed out that it was analagous to the action in a closed conductive circuit. In the latter they got current in the conductor and magnetic field, or lines of force around ; in the former a magnetic current, or displacement and a current. The influence outside of a closed magnetic circuit was very small, but if the alternations were largely increased, as they were, say, in Sir D. Salomons' machine, it might become important.

Prof. Perry would say something on the extra drop, and referred to his explanation of it in the paper to the Royal Society. Calling V_1 the primary volts, N_2 and N_1 the secondary and primary turns respectively, and $R_1 = R_2$ the respective resistances ; also x the sum of the leakages in both coils, and M the mutual induction; then the current was represented by the following equation :

$$\frac{V_1}{\frac{N_2}{N_1} R_1 + \frac{N_1}{N_2} R_2} = \text{secondary current;}$$

but the product Mx was the important thing, and to get the extra drop that must be added to the resistance in the equation. The full explanation was given in the Royal Society's paper. The following figures were given of a Mordey transformer actually tested—*f* = frequency :

f.	Lag.	Increase of drops per cent.	Drop.
100	6°	0·56	1·97
150	9°	1·25	2·66
200	12°	2·23	3·64
250	15°	3·48	4·89
300	18°	5·01	6·42

As the product Mx caused the drop, and as x was less in closed circuit transformers and M in open, it might be possible that in the different transformers the factors neutralised themselves.

Mr. Maycock referred to a series of experiments on the phenomenon or current rushes.

Mr. Sparks also referred to a series of experiments carried out since the reading of the paper.

Mr. Wright spoke of the great value of Prof. Fleming's paper, and in various ways tried to impress upon electrical engineers that transformers could not compete with the low-pressure system within a radius of 1¼ miles from the central station. He stated that the loss on a modern 20 h.p. transformer with 99 per cent. efficiency was the same as the cost of three-wire mains of 1¼ miles in length.

Prof. Fleming being absent it was stated that his reply would be inserted in the *Proceedings*.

The meeting then adjourned to January 26.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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HOW TO OBTAIN BUSINESS.

There are many men who would willingly pay a large sum of money in order to obtain a certain method, so that they could increase their business. A successful business has something in common with a good incandescent lamp light. The success of the latter is due to the last few volts of pressure, for if these are absent the light is merely a glow from a red-hot filament, and we require the glow from a white-hot filament ; so the success of a business is due to the work turned out over and above a given quantity. The administrative expenses have to be paid, and in order to pay these as well as the other expenses a certain minimum of work has to be turned out. After this point has been reached, administrative expenses take no further share in the profits. The paying part of a concern, then, is this additional turn-out. How to place a business in this fortunate position is the problem before every manager. Attention has often been called to various methods of transacting business which lead to a good deal of trade friction, and which do not in the long run ensure success. Let us take one or two of these methods for examination. First, the young beginner puts his prices down a little, and so obtain orders. He has had insufficient experience to know that his expenses will be greater in proportion to those of older firms, and after a short season the trade knows him no more. But the harm he has done remains. In order to keep himself floating, workmanship and materials have been deteriorated, and the buying public are led to imagine they can get what they want for the prices he has quoted. An example often mentioned in business ears is that of a traveller who heard of an order being given out, and whose firm had not been asked to tender. The gentleman waited on the principal, explained the purpose of his calling, and at once offered to do the work 25 per cent. under any other quotation. He knew no details of the work ; but, gain or lose, that was the way he went about obtaining business. Now, we contend that his way was not the right way, and that persistence in so doing would lead inevitably to disaster. Did the man get the order, and did his firm execute it? some readers may ask ; but answering these questions would remove our discussion from the general towards the special, and we have no intention to indicate men or firms.

Another class of men are vain enough to imagine that they have only to hang out their sign and business will come to them. This is an error. To obtain business you must be always aggressive. Go after the business, and the business will come to you. But there is a limit to aggressiveness, and not knowing this fact has led and will lead to many a trade quarrel. Assume that half-a-dozen firms know an order is going and each tries to get it. Gradually it is seen that one is far and away before the others in influence. Under these circumstances it is not true business for one of the other firms to try and "spoil sport." The others should accept the situation, take it they are beaten upon their merits, and hope for success elsewhere. A worse case is that in which a constituency has been nursed—that the principals have been made to turn their eyes in the direction of giving an order by some persevering firm which has long, quietly, and at considerable cost educated up to the buying point the constituency. For another firm to gratuitously come and attempt to outbid the pioneers is not business. Rather go and educate another constituency likewise.

Turn to another phase of business connected with another branch of the profession. There are men who will not take apparatus, no matter how good it may be of its kind. They insist upon modifying this detail and that detail of the apparatus—modifications which the manufacturers know, and which the buyer might know, lead to no better result than is obtained in the ordinary apparatus. It leads to surprise that the manufacturer quotes higher prices for the modified apparatus. It is expected that he will sell that one piece of apparatus at the same price he would sell one out of a thousand made similarly. This person who orders is either conceited or ignorant. If the former, his desire is to be unique—to get more attention because he gives more trouble. If the latter, he does not know that new patterns are costly affairs—he thinks that because the change is small the trouble is small. Such men lead rather to the decreasing of business than to the increase. When a manufacturer can make to stock sizes, his expenses in that direction are reduced to a minimum.

We have previously referred to the educating policy, and as an example of the good work being done in this direction may point to what Mr. H. J. Dowsing has done, and is doing, to educate users of electrical energy upon the subject of the application of electricity to many household purposes. It must not be thought that his teaching refers only to cooking—that is a salient feature appealing to every housewife, and even to the bachelor for hot shaving water or boiling water, for the early cup of coffee is not to be despised by the lonely man. Of course the ulterior object of Mr. Dowsing's educational crusade is to increase the load factor in central stations. He is doing work indirectly for every central station in the kingdom, and by and by in thousands of cases apparatus will be supplied, the energising of which will create a demand upon the central station and reduce its difficulties to a minimum. Others will partake in the advantages of the crusade, though they have nothing to do with the mental or monetary troubles of the same. Such are the men who make business. They look ahead, and find out directions in which purchasers may be found for electrical energy, and then set to work to prove to the probable purchasers that it is to their interest to buy.

Lastly—for we are running to great length—the motto for the year 1893, if you want to do business, is: Good workmanship, the best materials, moderate profits, and punctuality.

Train-Lighting.—The Northern Railway Company of France, after satisfactory experiments, have decided to light all their trains throughout by electricity.

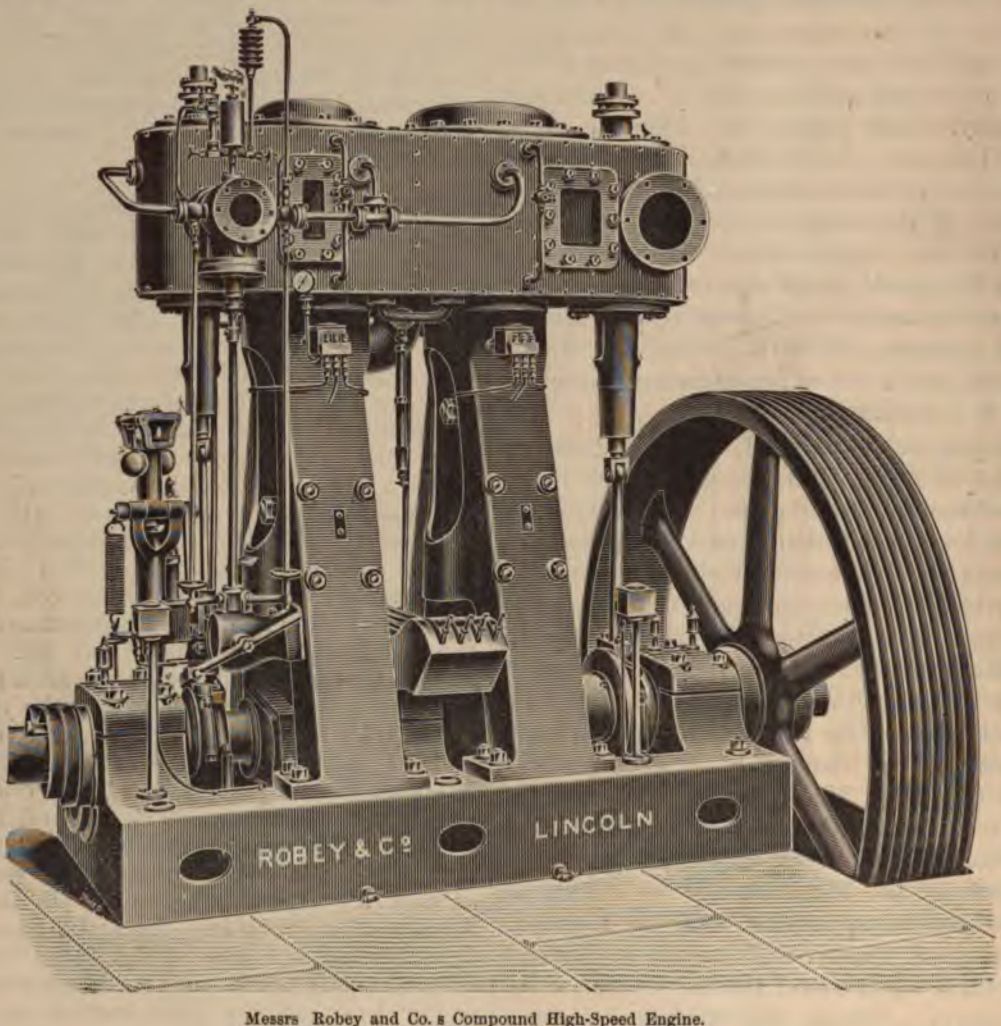
BUSINESS DURING 1892.

(Continued from page 25.)

Fahie and Son.—This Dublin firm has been fairly busy during the year in connection with the electrical industry, and especially in the capacity of consulting electrical engineers. Ireland, we are glad to notice, is not lagging behind in matters pertaining to electricity, and we find its capital is now regularly equipped with an electric light installation which may be considered one of the most complete in the kingdom. The full load—viz., 10,000 8-c.p. lamps—of the present private light plant has been all but reached, and the question of further increasing the machinery, or establishing a second station, is now under consideration. Bray, Carlow, and Larne are also lighted by the new illuminant, and Belfast is about to plunge into the sunshine of the "light of the future." Mr. Angelo Fahie, the junior member of the firm, has been engaged in writing some interesting contributions for scientific periodicals during the year, and has quite recently contributed to electrical literature a practical and popularly-written treatise, "House-Lighting by Electricity."

India Rubber, Gutta Percha, and Telegraph Works.—In addition to the usual indiarubber and guttapercha manufactures, the following work has been carried out by the electrical departments: A submarine cable of over 2,100 knots in length has been made and laid, connecting the network of cables at Senegal, Africa, to Pernambuco, in Brazil. Another cable, to duplicate the system originally laid by this company for the Central and South American Company, has now been completely manufactured and shipped on board ss. "Silvertown." This cable, of a total length of 2,620 knots, will be laid from Salina Cruz (Mexico) to Chorillas, Peru, touching at St. Elena (Ecuador) and San Juan del Sur (Nicaragua). In addition to the above, a considerable amount of cable has been manufactured for some of the telegraph companies, and the British and foreign Governments, making in all a total of about 5,400 knots manufactured during the year. Electric light cables have been supplied, and in some cases laid, for the underground electric light system of the following towns: Dublin, Leeds, Oxford, Cambridge, Dundee, and Glasgow. The demand for cables and wires for installation work has been very satisfactory, and the Silvertown Company has been fortunate enough to secure, practically, all the orders for Admiralty main cables—from the time that indiarubber insulation has been adopted—to replace the fibrous covering previously used, but now abandoned. A fair business has been carried on in electrical machines, including a few sets of dynamos supplied to the British Government, and the extension of the Hague Tramway Company, which is run on the accumulator system, with most satisfactory results, both as regards freedom from breakdown and receipts. In addition to the above, installations have been carried out for ships, factories, and private houses, and the instrument and batteries shops have been fairly well employed on Government and other work.

Robey and Co.—This firm send us an illustration of their compound high-speed engine, several of which have been supplied during the past year for electric lighting work. The firm's description of this engine is as follows: The type of engine shown above is made in sizes to indicate from 50 h.p. to 260 h.p., and to run at speeds of from 150 to 300 revolutions per minute. The framing and base-plate of engine are of most massive and substantial character. The working parts are strongly made, and all bearings and working surfaces are of ample dimensions, so that high speeds may be attained and continuous runs made without difficulty, danger, or anxiety. All the surfaces are amply lubricated by automatic feeders, all the moving parts being fed from one central box, and each of the three main bearings having two sight-feed self-acting lubricators. All parts of the engine are very accessible for examination and repairs, and every part is accurately balanced so that the engine can run at high speed without shocks, vibration, or noise. In case the crank ever requires taking out, it can easily be done by removing the front part of framing, which is arranged for the purpose, an operation which requires only a few minutes. The governing of the engine is perfect, a constant speed being maintained under very varying loads and pressures. The ratio of expansion is regulated automatically by Richardson's patent governor (of which Robey and Co. are sole makers), and thus the greatest possible economy of steam is obtained as well as perfectly uniform running.



Messrs Robey and Co. s Compound High-Speed Engine.

MANCHESTER EDISON-SWAN COMPANY. — This company has had an unusually busy year. Not only has the volume of their installation work considerably increased, as will be seen from the following list of some of the installations which they have carried out during the year, but they have considerably increased their manufacturing department, of which dynamo-building forms a considerable part: Union Club, Brazenose Club, Palatine Insurance Company, Commercial Union Assurance Company, Union Bank of Manchester, *Manchester Courier* Offices, *Sheffield Independent* Offices, Empire Theatre of Varieties, the Empire Theatre, W. Wood (Prince's Restaurant), Tyson's Restaurant, Queen's Hotel, Grimsby Town Hall (rewiring), Wholesale Co-operative Society's shoe factory, M. Ross and Sons' warehouse, W. Turner and Sons' cotton-mills, North British Rubber Company, Baerlein and Co.'s warehouse, J. Wood Bros. and Co.'s cotton-mills, Tootal, Broadhurst, Lee, and Co.'s cotton-mills, F. Martin, Esq., Inman Steamship Company, Limited, Bruderer and Co.'s warehouse, Elkington and Co., J. Whitehead, Bye and Co., Limited, C. Lowe and Co., W. B. Pidduck, A. Clason and Co., Stephenson, Routley, and Co., Miles Ashworth mills; Muir, Duckworth, and Co., J. Wainwright, J. Hall and Co., F. Livingston and Co., Schofield Bros., W. H. Milner and Co., F. Baum, John Martin, Esq., S. Hartley, W. Jowettt, Thompson, McKay and Co., Henderson, Craik, and Co., Simpson, Howden, and Co., Cunliffe and Swires. As a result their present factory in Little John-street, Manchester, has become too small, and they are projecting a large new works outside the town. In the course of a month they hope to move their present showroom from Barton-square to new premises which they are building on the Exchange Station-approach. They will there have in addition to the principal showroom, which has a window frontage of over 38ft. to the street, dark-rooms in the basement fitted up by eminent fitting manufacturers, also several sets of electric plant in operation. This company is at present applying for a provisional order covering the districts of Altrincham and Bowdon (the most wealthy residential suburbs of Manchester), and propose to lay down a central station having a capacity of 15,000 8-c.p. lamps.

NEW ZEALAND.

The illustration given herewith shows Princes-street, Dunedin, looking south, with the overhead electric railway. From advices from New Zealand, we think there should be a fair demand in the immediate future for electrical apparatus. The small electric light plant sent out by Messrs. Crompton and Co. to the Round Hill Mining Works is giving great satisfaction, and is highly spoken of by those who have visited the scene of operations.

View o. Princes-street, Dunedin, showing Overhead Electric Railway.

GAS POWER FOR ELECTRIC LIGHTING.*

BY J. EMERSON DOWSON, M.I.C.E.

The author stated that in Great Britain alone gas-engines had been sold for electric lighting exceeding in the aggregate 7,000 h.p., and that in Germany engines were used for about 1,100 arc and 90,000 incandescent lamps. It was, however, only within the last few years that gas-engines of large size had been before the world in a practical form. The varying load factor in central stations was a serious trouble, and the author hoped to show that much of the present loss due to fuel, water, and wages would be avoided if gas power were used instead of steam power.

Special reference was made to the central station at Dessau, belonging to the German Continental Gas Company. That station was opened in 1886 with two 60-h.p., one 30-h.p., and one 8-h.p. (effective) engines, worked with town gas, and all the dynamos were driven by belting and countershafts. In 1891 considerable alterations were made. One 60-h.p. engine, with its belting and countershaft, was retained, and one of 120 h.p. introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of town gas was equal to 39 cubic feet per kilowatt. Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the supply, so that they should always be worked to their full extent. It had, however, been found that a limited supply could more advantageously be furnished entirely from accumulators. In spite of the loss of about 21 per cent. in the accumulators, large engines worked more profitably in parallel than smaller ones supplying direct without accumulators. Since February, 1889, the Municipality of Schwabing, a suburb of Munich, had used an Otto engine worked with Dowson gas for 10 arc lamps and 300 incandescent lamps. The load was variable, but with an average output of 22·5 kilowatts per hour the fuel consumption was 3·3lb. per kilowatt. The town of Morecambe was lighted by nine arc lamps and incandescent lamps, equal to 1,600 of 8 c.p. each, the dynamos being driven by Stockport gas-engines worked with Dowson gas. With an output of only 1,155 kilowatts per week, the consumption of fuel was 2·58lb., and the cost of the gas, including wages and fuel, was ½d. per kilowatt delivered. At the château of Mr. Say, at Longpont, in the South of France, there were 650 incandescent lamps and one arc lamp, supplied by a dynamo driven by a Crossley engine worked with Dowson gas. The consumption of fuel was 1·2lb. per indicated horse-power, and 2·7lb. per kilowatt per hour.

It was believed that the late Sir William Siemens first drew attention to the fact that when illuminating-gas was burnt in a gas-engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly the consumption of gas per horse-power in gas-engines had been reduced, and the ratio was at the present time about 20 to 1 in favour of converting the gas into an arc light by means of a gas-engine. The author had collected data from various sources as to the consumption of ordinary town gas by engines supplying electric light, with and without accumulators. The average of all the returns, with engines under varying loads and without accumulators, was about 47 cubic feet per kilowatt-hour; when accumulators were used, the consumption of gas was less, because the engines then worked under a full load. With 47 cubic feet per kilowatt, and 55 watts per 16 c.p., one light of that power required only 2·6 cubic feet per hour, whereas a standard argand burner required five cubic feet per hour. In this comparison it was assumed that the incandescent lamps and gas-burners were in good order, but under ordinary working conditions they did not maintain so high a duty.

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* Paper read before the Institution of Civil Engineers.

The question of load factor was a serious one with any type of engine, but with gas-engines the loss was much less than with steam-engines. When a gas-engine was stopped its consumption of fuel stopped also, and there was no furnace to maintain; nor was there any water to boil at starting. At the same time it was desirable that the gas-engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed. A central station was worked under trying conditions, and in the London district there was only a full output of current during from three to five hours in every 24; moreover, about 60 per cent. of the total output was required during that short period. In practice this meant that in a station where the current was supplied without accumulators the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the daytime when there was fog. Generally, it might be assumed that the average consumption was more than 6lb. per kilowatt where accumulators were used, and about 9lb. to 12lb. where they were not used. In any case, with the best possible arrangement of steam power, there must be a large amount of fuel consumed which did no useful work; for, even if some of the fires were drawn, they had to be relighted, and the large quantity of water which had cooled during the time of standing must be reheated.

The author believed that the solution of the difficulty was to be found in the use of gas plant instead of steam plant. With a large gas-engine, 1 b.h.p. per hour could be obtained with a consumption of about 1lb. of anthracite, or 1¼lb. of coke; whereas the consumption of coal with the steam-engines used for central stations must be taken at about 2½lb. per brake horse-power, when working under a full load. A saving of not less than 50 per cent. could therefore be effected in stations where the engines were fully loaded; and, where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided. For a maximum of 400 kilowatts, there would be three gas-generators, each capable of supplying one-third of the maximum required.

The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately, by shutting off its steam supply. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected; and, when the production of one or two generators could be dispensed with their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas-generator had a small grate area compared with that of a boiler, and much less cooling surface; it contained no water and required no chimney draught. A generator of the size referred to lost only 6lb. to 8lb. per hour whilst standing. If an average of only 40 per cent. of the maximum power were required for 21 hours, it was equivalent to letting two of the generators stand for that period; and at 8lb. each per hour, that meant a total loss of only 3cwt., compared with the much greater waste when steam power was used. As the use of large engines driven with generator gas was of recent date, the author proceeded to describe the gas plant used, and gave the results of engines working regularly with Dowson gas, under the usual conditions obtaining in factories. He also gave the results of brake tests made with several engines of large size, and reproduced indicator diagrams taken from engines of different makers. Although admirable results had undoubtedly been obtained from engines working with the Otto cycle, he was of opinion that, with engines of large size, the results would be still better if the cycle were altered, especially when generator gas was used. His reasons for this were fully stated in the paper.

The following was a summary of the points urged by the author:

1. When town gas was used for driving the engines of an electrical station, the consumption was about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners.

2. When town gas was used, neither boiler nor firemen were required, and there were no ashes to remove; less space was needed; no accumulators were required, except such as might be necessary to equalise the load of the engines and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed.

3. When generator gas was used, the consumption of fuel under a full load would be at least 50 per cent. less than with steam power, and the loss due to steam boilers not being fully worked could be almost entirely avoided.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TESLA'S EXPERIMENTS.

SIR,—Having seen in the last issue of your valuable journal an account of the simplification of Mr. Tesla's experiments, I thought it might be of interest to forward to you a short account of a few experiments I have been able to perform with a much smaller coil than that used by M. Schoentjes. The coil is only 12cm. long and 6cm. in diameter, and works with an ordinary spring contact-breaker. However, from the secondary of this coil I have obtained a luminous wire similar to that of Mr. Tesla in addition to the experiments with vacuum tubes by M. Schoentjes. By placing two fine wires parallel to each other at a distance of about 2cm. on glass supports, and connecting each to a terminal of the coil, I have made the wire attached to the positive electrode luminous. This was done simply by means of the single coil and spring contact-breaker. I also obtained a luminous wire by placing my hand near the positive wire, having the negative free. The appearance of the wire was like small beads of light strung on it. By means of a wire connecting the positive pole to a vacuum tube (the negative being left free) the tube was lighted at a distance of 20ft. I have also performed the experiment of lighting a tube in the hand by connection with only the positive pole through the body. I have obtained these results with as low a battery power as two chromic acid cells.—Yours, etc., A. W. HOLLINGDALE.

Archway House, Dorking, Jan. 11, 1893.

MULTIPHASE TRANSMISSION OF POWER.

SIR,—I will take care that the additions for which I am indebted to Herr F. T. Eggers, representing the Allgemeine Elektricitäts Gesellschaft, are inserted in the completed edition of my paper on the generation and long-distance transmission of E.M.F.—Yours, etc.,

London, January 9th, 1893. B. H. THWAITE.

SIR,—Referring to my letter in the last issue of your esteemed journal, I have now the pleasure of enclosing a statement from the Allgemeine Elektricitäts Gesellschaft, of Berlin, which forms a full reply to Mr. B. H. Thwaite's questions appearing in the *Electrical Engineer* of December 30th, 1892, and I trust that this gentleman will give these facts the same publicity accorded to other firms enumerated in his paper at the Manchester Association of Engineers.—Yours, etc., F. T. EGGERS, General Manager,

Electrical Company, Charing Cross-road, W.C., Jan. 11.

Apart from the fact that the vital importance of the participation of the Allgemeine Elektricitäts Gesellschaft in the Lauffen-Frankfort transmission of power scheme was fully discussed in the exhibition publications and the journals and newspapers of the day, and was fully recognised on all hands, the following points may be mentioned. These will be fully confirmed by the official reports of the commission of enquiry and the exhibition committee, which unfortunately have not yet been published.

The scheme could only have been initiated and carried through by the co-operation of the Allgemeine Elektricitäts Gesellschaft, and not only their financial aid in advancing about £10,000, but the engineering works and the drawing office of the above firm were also essential factors in the undertaking. The scheme is based on the "Drehstrom" system of Dobrowolsky, the well-known chief engineer of this firm. The high-tension system employed was only rendered possible by the use of the transformer patents of the A.E.G. The A.E.G. selected, arranged, tested, and delivered the oil insulators.

They carried on all the complicated technical—as well as the financial—and political negotiations with the Imperial and other authorities and railway officials. The Oerlikon Works, as is well known, are licensed to work the "Drehstrom" patents of the A.E.G., and what Mr. C. E. L. Brown constructed alone and independently of the A.E.G. was the alternating-current dynamo installed at Lauffen, and used as a "Drehstrom" dynamo by the application of a rotary-current commutator.

The arrangement of the whole installation was entrusted to the A.E.G. The switches, the measuring, regulating, safety, and accessory apparatus in Lauffen, as well as in Frankfort, were constructed and delivered exclusively by the A.E.G. The safety appliances in connection with the high-tension conductor, to which (taking into consideration the at that time completely unknown conditions of tension) the regular working and perfect success of the transmission of power were largely due, were constructed at the suggestion of the A.E.G., and in accordance with their ideas and drawings. Although not now considered remarkable, the insertion of safety fuses in a 300-h.p. circuit at 30,000 volts was at that time considered extraordinary and almost impracticable.

Then with regard to the transformers and the motors at the points of consumption, it was at first agreed that the transformers should be delivered by the Oerlikon Works, according to the system and under the patents of the A.E.G., since Oerlikon was not in a position to build any other multiphase transformers than these; and during their construction the A.E.G.'s engineer, Herr von Dobrowolsky, constantly assisted the Oerlikon Works with his advice, and was especially instrumental in overcoming many difficulties arising from the radial arrangement of the three cores in the "Drehstrom" transformer, by suggesting the parallel position for these. In the course of negotiations, lasting over months the Oerlikon Works, however, declared that they would assume any responsibility or guarantee for the construction of the transformers, and the whole scheme was all but wrecked. The A.E.G., however, although up to then they had only constructed such transformers on a much smaller scale, took the bull by the horns, and resolved to build the necessary transformers simultaneously with the Oerlikon Works, for the primary as well as for the secondary station. This was done; the A.E.G.'s transformers were ready and delivered first, and eventually a double supply of transformers was thus available both in Lauffen and Frankfort, and the transformers of both works were used alternately.

To the credit of both establishments, be it said that the whole of the transformers were faultless and yielded a splendid efficiency. With regard to the motors connected with this plant, the A.E.G. furnished three built by themselves, of which one was of 100 h.p., and the Oerlikon Works one—viz.., a 20-h.p. motor with Dobrowolsky armature.

The working, organisation, instructions for working the apparatus, supervision, and general carrying out of the scheme devolved on the A.E.G., and they alone were responsible for the same.

(Signed) E. Rathenau, General Director.
Allgemeine Elektricitäts Gesellshaft, Berlin, Jan. 6, 1893.

SKATING BY ELECTRIC LIGHT.

Sir,—In your issue of 6th January, on page 3, I notice a statement to the effect that Acton is perhaps the only place where electric light is used for skating purposes. I should like to remark that at Belle Vue Gardens, Manchester, electric light has been used, I believe, for at least two years for skating, about six arc lamps being employed to illuminate one of the lakes at night.—Yours, etc.,

W. P. Steinthal.

COMPANIES' MEETINGS.

LIVERPOOL OVERHEAD RAILWAY.

On Tuesday a special meeting of the shareholders of the Liverpool Overhead Railway was held at the Law Association rooms, Liverpool, Sir W. B. Forwood, the chairman, presiding over a large attendance. The meeting had been called to consider the following resolution: "That £120,000, being the whole of the share capital authorised to be created by the Liverpool Overhead Railway Act, 1892, be and the same is hereby created in 12,000 preference shares of £10 each, bearing interest at the rate of £5 per centum per annum, and that they be and they are hereby authorised to issue 7,500 of such preference shares in such amounts and manner at such times and on such terms as they may think fit; that the holders of the preference shares created shall be entitled to vote on the same scale of voting as the holders of ordinary shares."

The **Chairman**, in moving the adoption of this resolution, said they would have gathered that the object of the meeting was to obtain sanction for the creation of 12,500 5 per cent. preference shares of £10 each and authority to issue 7,500 at par. They were compelled by the rules of the Stock Exchange to make a public issue of the shares, but the applications from the shareholders and bondholders would be favourably considered. The calls would be spread over 15 months, say, not exceeding £2 each three months. The additional £75,000 capital was needed to carry out the northern extension for which parliamentary powers were obtained last year, and which would cost about £37,000. As the extension would carry their line to Crosby-road, Seaforth, they looked for a considerable traffic from that very populous and increasing suburb. No doubt in summer time there would be a large holiday traffic, as the station would be close to the Seaforth shore and sands. The extension ought to be proceeded with at once, for without their railway along the Hornby Dock would be without a feeder, seeing that the dock service practically ended at Strand-road, Bootle; and, further, it could not be constructed at a less cost owing to their manufacturing plant being on the spot. The remaining £38,000 was required to complete the present undertaking. The adoption of electricity instead of steam, and the working of signals by electricity, had entailed, as before explained, a considerable additional first cost. This, however, they regarded as a very wise outlay of capital, for they expected to reap great advantage in the great economical working of the line. There had also been an increase in the cost of the accommodation works which were necessary for preparing the site and sinking the foundations. He was glad, however, to tell them that they were through with their construction difficulties. Except for the adjustment of some of the handrailing the line was now complete. They were now fitting and testing the electric signals, and equipping the train with electric motors, operations which required great care. The line would be formally opened by the Marquis of Salisbury on Saturday, February 4, and they then proposed to run the line for a week or 10 days to get everything into working order before throwing it open to the public. So far, the trial trains had been in every way satisfactory, both as to speed and quickness in starting, and smooth, noiseless running. The loss in power between the steam-engine and the dynamo did not exceed 5 per cent. Therein, he thought, was to be found the great economy of electricity. They could use only coal sufficient to produce the exact amount of electricity required to move the trains, and so nicely was this adjusted that the few seconds a train waited at the station meant less electricity used and less coal consumed. If they were employing steam-locomotives, every locomotive would be under full steam, no matter if the trains were heavy or light, or if they stopped for a short or a long period. The introduction of electrical signalling would also effect a considerable economy in their working expenses of not less than £1,500 per annum. The Directors had had to make large demands upon their patience, and they gratefully appreciated their forbearance. Their task had not been a light one, but they were pleased to be able to hand over to the shareholders a property second to none in the substantial character of the work, and which would not only confer great advantages upon the trade of the port, but which would, they believed, prove a thoroughly sound and profitable investment for their money. He explained with regard to the preference shares that they proposed to call 10s. on application, £1. 10s. on allotment, and further calls of £2 at intervals of not less than three months.

Mr. R. Hobson seconded the resolution.

Mr. Inglis, who said the shareholders demanded as a right that they should have the first offer of the preference shares, moved as an amendment the addition to the resolution of the followfng words: "That such preference shares be offered in the first instance to the ordinary shareholders of the Company."

This was seconded by **Mr. Hughes**.

Several gentlemen spoke in favour of the amendment, and both the **Chairman** and the **Secretary** (Mr. W. H. Alexander) pointed out that unless a public issue were made of the preference shares they would not be quoted on the Stock Exchange. The **Chairman** added that he thought they might safely leave the matter in the hands of the Directors, who would be mindful of the feelings of that meeting, and that first considerations were due to those who had borne the heat and burden of the day, and had had their money in the Company for several years without receiving any return.

The amendment on being put to the meeting was lost, 17 voting in its favour and 21 against. The resolution was then adopted, and the meeting closed with a vote of thanks to the chairman.

INTERNATIONAL OKONITE COMPANY, LIMITED.

Directors: Samuel Pope, Esq., Q.C. (chairman); Sir Alexander Armstrong, K.C.B., F.R.S.; Harry Hankey Dobree, Esq.; Major Charles Jones; John Henry Tod, Esq. Directors acting as a local committee in New York: John H. Cheever, Esq. (vice-chairman); W. L. Candee, Esq.; H. Durant Cheever, Esq.; Edward Lyman Short, Esq. Managing Director: Alfred Vaughan-Stevens.

Second annual report of the Directors presented at the ordinary general meeting, November 30, 1892.

In forwarding the accounts for the year, the Directors greatly regret that they show so unsatisfactory a result. Difficulties have arisen during the year both in America and in England, which have rendered the labour of your Directors extremely anxious and onerous, and they have thought it their imperative duty to lay before their shareholders the accounts based upon such valuations as they think can be supported. The former valuations upon which dividends have been declared and paid were, as regards stocks in America, made by the American managers, but the course of business during the year satisfied your Board that those valuations had been largely over-sanguine, and they accordingly represented to the American managers (despatching the managing director, Mr. Vaughan-Stevens, to New York, to enforce their views) that some rectification of those valuations should be made in justice to the shareholders of the Company. After a long and anxious negotiations, the Board induced their American colleagues to surrender, for the general benefit of the concern, a sum of £20,000 in shares, which had been allotted to them as part payment of the purchase price. Had your Directors felt justified in continuing to value the assets on the former basis, the profits of the year would, of course, have appeared to be much larger than they are; but they have felt that at any sacrifice it was desirable that the accounts should start with a real, and not a sanguine valuation of assets. The small profit on the American business, therefore, largely arises from the reduction in assets by valuation on a sounder basis. In the balance-sheet this matter has been dealt with, as you will see, by writing off £20,000 from the capital of the Company. Although the American business, with this aid, shows a small profit, the loss which has arisen on the Manchester factory absolutely necessitates an immediate reorganisation of its administration, and as your Directors have succeeded in obtaining valuable contracts in connection with the electric lighting of Manchester, Whitehaven, Melbourne, and other important places, they look forward with hope that such reorganisation may result in a more satisfactory account in the future As the Directors find that the accounts as audited show a total loss on the year's operation of £6,886. 3s. 9d., they are unable to recommend the payment of any dividend. They think it right, however, to say that in making up the accounts full depreciation on all plant has been allowed for, and an amount set aside for contingent liabilities or bad debts, which, with this depreciation, more than accounts for the deficiency in question. The auditors, Messrs. Price, Waterhouse, and Co., retire, and being eligible, offer themselves for re-election, which the Directors recommend.

Profit and Loss Account. New York to May 31, 1892, and England to June 30, 1892.

Dr.	£	s.	d.
London office expenses	1,352	7	0
Directors' and managing directors' remuneration	2,500	0	0
Legal and professional charges	582	13	0
Audit fee	63	0	0
Trustees for debenture-holders' remuneration	200	0	0
Travelling expenses	157	3	8
Interest on debentures	4,409	10	4
Depreciation of furniture and fixtures, London office	86	12	3
Loss on exchange	53	4	1
Interest and bank charges	939	6	8
	£10,343	17	0

Cr.	£	s.	d.
Profits of American business, after including the amount of share capital agreed to be surrendered by the managers and cancelled as compensation for excessive valuations of stocks, and after writing off depreciation	5,689	17	11
Less loss on Manchester business after writing off depreciation	2,242	9	8
	3,447	8	3
Transfer fees	10	5	0
Balance. Loss carried to balance-sheet	6,886	3	9
	£10 343	17	0

Balance-sheet. New York, May 31, 1892, and England, June 30, 1892.

Dr.				£	s.	d.
17,000 preference shares of £10 each				170,000	0	0
Less 1,000 ditto, agreed to be surrendered by managers and cancelled, £10,000; and five ditto forfeited, £50				10,050	0	0
				159,950	0	0
17,000 ordinary shares of £10 each, £170,000; less 1,000 ditto agreed to be surrendered by managers and cancelled, £10,000				160,000	0	0
				319,950	0	0
Deduct—Calls in arrear				1,015	0	0
				£318,935	0	0
Amount received on shares forfeited				5	0	0
Debentures: 1,000 bonds issued of £100 each	£100,000	0	0			
Deduct 150 bonds issued to bankers as security for loan	15,000	0	0			
	85,000	0	0			
Less instalment unpaid	1,805	0	0			
				83,195	0	0
Debenture interest due and accrued and outstanding dividend				1,927	19	5
Loans and mortgages from bankers	10,307	9	4			
Mortgages	4,200	0	0			
				14,507	9	4
Sundry creditors				23,960	16	2
Bills payable				25,469	18	11
				£468,001	3	10

Cr.	£	s.	d.	£	s.	d.
Purchase of properties and businesses in America and Manchester, as per balance-sheet at June 30, 1891	218,979	14	1			
Add—Expenditure on new factories in America and Manchester, and purchase of lease (999 years) of mill at Newton Heath, Manchester	7,334	2	6			
				226,313	16	7
Plant and machinery, tools, etc., as per balance-sheet, June 30, 1891	79,023	16	1			
Additions since	11,297	0	7			
	90,320	16	8			
Less depreciation	5,472	15	9			
				84,848	0	11
Office furniture and fixtures, as per balance-sheet, June 30, 1891	1,556	18	1			
Additions since	207	4	8			
	1,764	2	9			
Less depreciation	161	15	3			
				1,602	7	6
Stock-in-trade				111,872	19	2
Sundry debtors				28,261	13	5
Bills receivable				769	12	9
Cash at bankers and in hand				5,774	6	7
Preliminary expenses—						
As at June 30, 1891	1,960	1	3			
Less amount written off out of profits to June 30, 1891	287	18	1			
				1,672	3	2
Profit and loss—						
Loss as per annexed account				6,886	3	9
				£468,001	3	10

The adjourned second ordinary general meeting of the above Company was held on Tuesday at the Cannon-street Hotel under the presidency of Mr. Samuel Pope, Q.C., chairman of the Company.

The **Chairman** said that he was unfortunately unable to be present at the general meeting, and no doubt the information which was then given to the shareholders was not of the fullest; but after some discussion that meeting was adjourned until then. The present assembly was, so to speak, a continuation of the general meeting, and it would therefore not be necessary that the familiar reading of the summons should take place. They would therefore resume the discussion on the report and balance-sheet at the point at which it left off before the adjournment. He would be glad for any shareholder to ask for any information upon any desired point. A few questions were raised at the last meeting upon which he would make a few remarks, and he was anxious that the shareholders should understand the position of the Company. The first question was that of £20,000, which had practically been refunded out of the purchase-money by the original vendors, who were the managers in America. That had caused them great anxiety and trouble at the commencement of the year. They had found in the course of their business, as stated in the report, that the valuation upon which their previous profits had been nominally based was practically an over-sanguine valuation. The Directors had therefore felt it necessary not to present a balance-sheet in which the credit assets were, in their judgment, over-valued, and therefore of necessity that balance-sheet had to be prepared upon an amended valuation of stock. The profits of the present year were of necessity diminished by the amount which they had thought it necessary to write off the original valuation because the profits had been upon the true valuation of the stock. The previous balance-sheet had been based upon a valuation for which the American colleagues and original vendors were responsible. They had sent their general manager over to the United States with a view to insist upon some return to the Company of the purchase-money which had been paid upon the basis of such a valuation. With considerable difficulty they had managed to induce them to return £20,000 of the shares which had been handed over to them in payment of the purchase-money. That amount had been treated as a reduction of the capital cost, and on any dividend earned there would be a percentage less to pay on £20,000. That seemed to him to be fairly and correctly stated in the report, and the amount was placed to their capital account. He would never have been a party to presenting a balance-sheet, although it might be that it would show no profit for the half-year, except that of over-valuation of stock; therefore one of the main features of the balance-sheet was this: that they hoped and believed that they had started with a proper valuation of their stock, and although the writing off of £20,000 prevented any profit from accruing this year, the benefit would hereafter be derived, because in the future there would be no such over-valuation to be contended with. Coming to minor questions, something had been said at the last meeting about the London expenses, which amounted to something like £2,000 odd. The Company, though largely consisting of property and business in America, had, by its constitution, to be managed by a Board sitting in London, but £750 of the sum of about £2,000 was repaid to the Company by other companies who used their staff and establishment, and thus the expenses were reduced by that amount. With regard to the Manchester business, there had been a considerable loss, and the Directors were unanimous in their opinion that the management of that business had not only been disastrous but disgraceful. They had, therefore, thought it fit to remove the gentlemen who had hitherto been in charge of the Manchester business. The Directors also believed that they would now be able to reorganise the Manchester works upon a basis which would render it satisfactory and profitable. They were equally unanimous that the agreement, which in the first instance had been made with the vendors of the Manchester business, had operated to hamper the discretion of the Directors, and that at any cost—if costs were necessary—that must be got rid of, and a clean sweep made at the Manchester end. Some of the shareholders had suggested certain views to the general body, and he (the chairman) considered that some of the suggestions were worthy of respectful consideration; but the first thing was to secure a sufficiently competent management. Then they would consider with more respect some of the suggestions made by certain shareholders. He referred more particularly to a circular issued, and to a certain number of proxies deposited with the Company since the last meeting. That number at the outside represented 1,863 shares, whilst the Directors held proxies to the extent of 11,221 shares. The substance of the circular, to which the Chairman referred in detail, was that the report called for the most complete investigation into the affairs of the Company, and that a committee of enquiry should be formed for the purpose. Mr. Pope said that if such a committee were constituted the Board would retire. The circular was signed by Messrs. Kenyon, Peters, and Thorp, Sir Edward Gladstone and Mr. Wm. Greville holding together 430 shares, representing, with the proxies, about 2,400 shares out of the total capital of the Company belonging to persons of that opinion. He then moved the adoption of the report and balance-sheet.

A long discussion then ensued, in which some pertinent questions were asked of the Board concerning the vendors, the statements in the prospectus, the figures in the balance-sheet, etc.

Mr. A. Vaughan-Stevens, the managing director, in reply to various questions, said that although he himself had been in charge of the agreements referred to in the original prospectus not a single shareholder applied to see those agreements. Although Woodhouse and Rawson, as the vendors, appeared on paper for £46,500, they had not received one penny, because the whole of the suppositititious profit was represented by shares which they took up in the Company. In November, 1891, he had been to the States in consequence of information received. One result of his visit was an alteration both in the management and the Board of Directors. He was not going to explain why, although claiming from £40,000 to £60,000 in cash, they only received £20,000 in shares, and for that matter it had been impossible to obtain more than that sum. As regards the working capital, that had been put down at £110,000, but an original £15,000 in debentures were not issued. This fact, combined with the remittance to America of £65,000 for working capital, reduced the amount of the latter in England to about £30,000. Unfortunately, owing to the advice of the experts of the Company, headed by Mr. Connelly, they had expended that amount of money before they knew where they were. To-day he was aware that a good deal of it had been foolishly spent, and the result of any of it would not be evident for some time. Having discharged their manager and others, they hoped soon to secure a competent man as works manager, their late representative in the latter position having grossly mismanaged the factory. He accused Mr. Kenyon of damaging the credit of the Company, and that would be specially the case in America. The last reports from the States showed that their business was increasing, and that it had almost reached the level at which it formerly stood when the largest sales took place under previous good management. That was an encouraging feature. He concluded by expressing the hope that notwithstanding the opposition of the discharged servants of the Company, they would surmount all the difficulties and place the business on a sound footing.

The **Chairman** then put the motion, which was seconded by **Mr. H Hankey Dobree.** This was carried by a large majority.

The auditors, after a counter-proposal was negatived, were re-elected, and the proceedings closed with a vote of thanks to the chairman.

Havre.—The municipality of Havre have authorised M. Pierre Burton to carry out the preliminary arrangements for a concession for an electric tramway between the quays and the Place de Montivilliers. The concession will be given without monopoly on payment of an annual royalty of 6,000f.

NEW COMPANIES REGISTERED.

Gordon and Fell, Limited.—Registered by Spencer Whitehead, 188, Fleet-street, E.C., with a capital of £100,000 in £10 shares. Object: to acquire as a going concern the business of J. E. H. Gordon and Co., Limited, electrical engineers, and the goodwill thereof, with the premises where the said business has been carried on, and the plant, machinery, stock-in-trade, capital, contracts, property, and effects of the said business, subject to the debts and liabilities; to carry on business as builders and contractors, workers and dealers in timber, manufactured and unmanufactured, and metals, brick and tile makers; to acquire the business now carried on by John Fell, of Leamington, and to carry on in any or all of their respective branches the businesses of manufacturing, supplying, and maintaining electric light machinery and apparatus, both for public and private purposes; to construct and maintain roads, waterworks, canals, tramways, quays, piers, wharves, etc. The first signatories are:

	Shares.
C F. Crowder, Apesdale, Bromsgrove	1
T. F. Pountney, Onego Villa, Green-lanes, Small Heath, Birmingham	1
H. A. Milward, 1, Peakman-street, Redditch	1
J. H. Brackwell, Avenue-road, King's Heath	1
T. H. Willday, 158, Albert-road, Aston, Birmingham	1
J. Cobley, Highfield, Jakeman-road, Birmingham	1
W. Tonks, Butley Dene, Cavendish-road, Birmingham	1

Unless otherwise determined by the company in general meeting, the number of directors is not to be less than three nor more than eight; the first to be appointed by the signatories to the memorandum of association. Qualification, 25 £10 shares or debentures to the value of £500. Remuneration, £200 each per annum; chairman, £50 extra.

New Cape Central Railway, Limited.—Registered by Munns and Longden, 8, Old Jewry, E.C., with a capital of £100,000 in £5 shares. Object: to acquire, by purchase or otherwise, the whole or any part of the property, undertaking, and rights formerly possessed by the Cape Central Railways, Limited, and, with a view thereto, to enter into and carry into effect an agreement expressed to be made between T. D. Bear of the one part, the Cape Central Railways, Limited (by the said T. D. Bear, its official liquidator), of the second part, and T. L Nottage of the third part, and to carry on the business of carriers by land and water, telegraph and telephone engineers, manufacturers, mechanical and electrical engineers, shipowners, shipbuilders, warehousemen, forwarding agents, and insurance agents. The first signatories are:

	Shares.
D. Reed, 7, Mincing-lane, E.C.	1
T. Drew, 225, Upper Thames-street, E.C.	1
L. H. Drew, 225, Upper Thames-street, E.C.	1
J. Ashton, 19, Great St. Helens, E.C.	1
W. Cunliffe, 118, Leadenhall-street, E.C.	1
F. B. F. Millard, 12, Lysander-grove, Holloway	1
E. E. Collins, 238, Portland-road, South Norwood	1

There shall not be less than three nor more than seven directors. The first are J. Ashton, D. Reed, and T. D. Bear. Qualification, 100 shares. Remuneration, £100 each per annum, with an additional £100 per annum for the chairman.

Roger Dawson, Limited.—Registered by E. L. Hicks, 3 and 4, Lincoln's-inn-fields, W.C., with a capital of £15,000 in £1 shares. Object: to carry into effect an agreement expressed to be made between A. R. Dawson of the first part, A. R Cobbett of the second part, C. E. Tomlin of the third part, J. H. Jenks of the fourth part, and this company of the fifth part; to acquire the business of Rashleigh, Phipps, and Dawson, electric light engineers and contractors, and to develop and extend the same. The first directors are A. R. Dawson and A. R. Cobbett. Remuneration, £500 per annum.

BUSINESS NOTES.

Poona.—The subject of the electric lighting of Poona has dropped for want of funds.

Burnley.—January 18 is the date fixed for receipt of tenders for fitting Burnley Town Hall for electric light.

Widnes.—The Widnes Town Council have resolved to consider the question of the better lighting of the town.

Switzerland.—The Municipal Council of Bulle, Switzerland, are inviting plans and tenders for a central station for light and power.

Globe Telegraph and Trust Company.—An interim dividend of 1s. 3d. per share has been declared by the directors, payable on the 20th inst.

Eastern Telegraph Company.—The receipts for the month of December were £59,776, as against £55,830 for the corresponding period of 1891.

Enfield.—The question of lighting the Chase Farm Schools at Enfield is now before the Works Committee of the Edmonton Board of Guardians.

Dundee.—The electric light is to be put into the Dundee Parochial Board offices, and an additional rent is to be charged by the Town Council.

Halifax.—The Halifax County Council have decided to take steps for supplying electricity under powers of their electric lighting order of 1892.

Cuba Submarine Telegraph Company, Limited.—The receipts for the month of December were £180 more than for the corresponding period of 1891.

Derby.—At a special meeting of the Derby Town Council last week, the tender of Mr. Vernon for £6,324. 17s. 5d. for building the electric lighting premises was accepted.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,507.

Train-Lighting.—The Southern Mahratta Railway Company, of India, are experimenting with gas for carriage-lighting. The home firms should supply particulars of electric lighting for trains.

Dudley.—The report of the Streets and Gas Committee of the Dudley Town Council has been adopted, without any reference being made as yet to the proposed lighting of the town by electricity.

Calcutta.—The question of the lighting of the new Imperial secretariat buildings in Government-place, Calcutta, will shortly be decided. It is thought that probably electric light will be provided.

Huesca.—The municipal authorities of Huesca, Spain, are willing to grant a concession for 20 years for the lighting of the town by electric light. The town guarantees a minimum custom of £800 a year.

Sophia.—Messrs. Ganz and Co. have been awarded the contract for the electric lighting of Sophia, Bulgaria. The power is to be obtained from high-pressure waterfalls, the water being conveyed in Mannesmann steel tubes.

Oxford.—The question of whether the arc lamps at Oxford were to be kept alight for the sake of advertisement in the summer time, or charged at a reduced rate, was referred at last meeting to the General Purposes Committee.

Utilising Destructors.—The St. Luke's Vestry are about to erect a dust destructor, the waste heat to be utilised for grinding mortar, chaff-cutting, and also for generating steam to enable the entire premises to be lighted by electric light.

Ipswich.—The resolution by Mr. Robinson at the Ipswich Commissioners' meeting last week was carried, that the subcommittee should report on the desirability of obtaining a provisional order for providing a supply of electricity.

Edinburgh.—The Electric Lighting Committee of the Edinburgh Town Council have met and discussed the terms of the report which they are to submit on their recent visit to England. The report is expected to be ready on an early date.

Salford.—At the monthly meeting of the Salford Town Council, Mr. Roper stated that everything possible was being done to complete arrangements with a view to the introduction of the electric light in the borough. The plans were now completed.

Transmission Patents.—M. Marcel Deprez, with M. Jules Carpentier, of Paris, have entered a suit against the Thomson-Hourton Company in the American Courts, to restrain this company from violating their transmission of power patents.

San Moritz.—Messrs. Michell and Bidermann, of San Moritz, have applied for a concession for the construction and working of an electric railway from the village of San Moritz to the baths of the same name. The length will be about 1¼ miles, to be covered in 10 minutes.

Personal.—Mr. W. Perren Maycock, M.I.E.E., has been appointed correspondent on electrical matters to the *Ironmonger and Metal Trades Advertiser*. All communications relating to new fittings, instruments, etc., should be addressed to him at 42, Cannon-street, E.C.

Deadheads.—The Blackpool Town Council have decided that no officer or servant of the Corporation except the borough surveyor, tramways manager, and police officers and firemen in uniform, should be permitted to travel on the electric tramways without full payment of the fare.

City and South London Railway Company.—The receipts for the week ending January 8 were £998, against £858 for the corresponding period of last year, or an increase of £140. The total receipts for 1893 show an increase of £140 over those for the corresponding period of 1892.

Chatham.—A curious complaint arises from New Brompton, a rival or suburb of Chatham. The electric light, say the tradesmen, makes a blaze of light in Chatham, and customers are attracted over the hill like moths to a candle. The remedy is obvious—extend the lighting to New Brompton.

African Cables.—The Eastern Telegraph Company, Limited, notifies that communication with South Africa is interrupted both *viâ* the west and east coast routes. The company's cable-repairing steamers are in the locality of the breaks, and communication is expected to be restored early next week.

Eight Hours.—It is stated, says *Industries*, that Messrs. Mather and Platt, Limited, are about to adopt the eight-hour day in their workshops, and the result of the experiment will be looked forward to with interest; no more unfavourable time could be chosen, as the condition of trade is such that prices are hard to maintain.

The Thames and the Severn.—Windsor, Kingston, Worcester, and Bewdley are thinking of, or are discussing, the use of water power. Would it not be well for the Thames Conservancy and the Severn authorities to obtain proper advice and draw up a full report on the subject for the guidance of the town councils?

Kingston-on-Thames having decided to adopt the electric light, Mr. W. H. Preece, engineer-in-chief of the Telegraph Department, has advised the authorities to provide both for public and private purposes, and to keep the work in their own hands. He is convinced that when fairly established it will prove remunerative.

Silicate Cotton.—Messrs. D. Anderson and Co., of 812, Old Ford-row, Bow, send us their prospectus of silicate cotton or slag wool, used for covering boilers or other non-conducting purposes. It is inexpensive, one ton covering 1,800 square feet 1in. thick. Illustrations are given of its application to pipes, boilers, and other purposes.

Liverpool Electric Railway.—With reference to this railway, "it is an interesting detail," says the *Daily News*, "that under the lease granted to the company no rent will be payable until the profits on the outlay amount to 6 per cent. per annum. Another hopeful sign is that the Bank of Liverpool took over the whole of the company's debenture issue."

Hull Theatre.—The Grand Theatre and Opera House just opened at Hull has cost over £20,000. The new theatre was built from the designs of Mr. Frank Malcham, theatrical architect, Warwick-court, London. It is richly decorated with marble staircases, and is fitted throughout with electric light. The front is picked out with electric lamps, together with two arc lamps.

Maidstone.—At the last meeting of the Local Board the Mayor moved that the Electric Light Committee be reconstituted. Last session it consisted of the following members: The Mayor, the ex-Mayor, Aldermen Clifford and Long, Mr. Barker, Mr. Cox, and Mr. Laurence. He proposed that they be re-elected. This was agreed to, and the names of Messrs. Seymour and Morling were added.

Canterbury.—The Electric Light Committee reported to the Canterbury Town Council last week, that at a meeting on the 28th December, a letter was read from Messrs. Mowll and Mowll agreeing on behalf of the Brush Company to pay the sum of £410, that being the sum estimated for costs. In answer to an enquiry, the Mayor said he expected they would commence work during the present summer.

Lewes.—The street-lighting of Lewes is a cause of dissatisfaction, as the gas company recently decided to put meters on every street lamp and charge rent for these as well as for gas burnt. The local press is highly indignant, and asks, as the Lewes Town Council have the street-lighting in their own hands, why not go in for electric lighting and be independent of the gas company altogether?

Rothesay.—At the monthly meeting of the Rothesay Harbour Trust and Town Council with reference to the proposed electric lighting, Mr. Milloy (convener) said the committee were not yet in a position to make any definite recommendation, but expected to do so in the course of a week, after visiting some places where electric lighting was supplied by a turbine wheel similar to what was proposed for Rothesay.

Train-Lighting.—The London, Brighton, and South Coast Railway has now 30 trains lighted by electric light. This should be an encouraging item to quote to other railway companies, and we do not think enough has been made of the success of the light on this line. The Electrical Power Storage Company have been, moreover, recently assured by the telegraph superintendent that there is every prospect of a considerable development in the near future.

Irvine.—An inspection was made last Saturday by Mr. David Alexander, from Messrs. Norman and Son, electrical engineers, Glasgow, of the Burgh Mill, Irvine, for the purpose of reporting as to the amount of water power. It is proposed to light the two main thoroughfares of the town, extending about three miles in all, and the harbour with electric light. The Town mill is to be utilised, and the committee have been empowered to employ an electrical engineer to report.

Whitehaven Lighting Contracts.—At the monthly meeting of the Whitehaven Town and Harbour Trust last week, the chairman moved that the seal of the Board be affixed to an agreement with Messrs. Higginbottom and Mannock for a crane, the tender for which was accepted at the last meeting of the Board, and also that the seal be affixed to an agreement with the Lowcra Engineering Company for reseating boilers, etc., the tender for which had also been previously accepted. This was agreed to.

Cheltenham.—The Cheltenham Town Council have referred back to committee the proposal to introduce electric lighting by the Corporation themselves. It is expected that the general feeling of the inhabitants will be sought by a public meeting. Cheltenham is a beautiful and fashionable inland watering place, and one quite as suitable to the electric light as Bath, for instance, or Brighton. It is to be hoped that the Council will be able to arrive at a practical conclusion, and introduce the light without delay.

Glasgow.—At the Glasgow Town Council meeting last week, with reference to the electric lighting, Mr. Ure stated that the committee expected to have had the work completed before the New Year, but they were not getting on as quickly as they anticipated.

It was then expected to be completed before the beginning of February, but he was afraid they would not have the electric light in operation even then, because in such weather as now prevailed it was impossible to open the streets and push on with the work as quickly as desirable, having regard to its efficiency.

Scarborough —Further steps have been taken by the recently-formed electric lighting company in the matter of introducing electricity for the purpose of lighting the town. About two acres of land, situate in Beaconsfield-street and Salisbury-street, have been purchased by the company from Mr. William Peacock, builder and contractor, near to whose brickworks the land is. Mr. Peacock has also received instructions to prepare for the erection of the works. The architects in the matter are Messrs. Hall and Tugwell, the secretary of the company being Mr. John Hall.

Deputations.—A select party of the Blackpool Town Council recently visited Helsby to inspect the Brain conduit system of traction. Councillor Bickerstaff brought up at the last Council meeting the question of the cost of this deputation—£8 18s. He objected to deputations spending the ratepayers' money without being first authorised. The deputation had not reported and no record appears. What is the matter, it is asked, with Blackpool's present electric railway? If they wish a better system, a proper report by an engineer would be more satisfactory than a deputation.

Taunton.—The Board of Trade having granted the license to Taunton—on the plea that while money had been lost, under new management the deficit would not be so overwhelming, and that the ratepayers would willingly pay for the better light—the case stands thus, says the *Somerset Express*: "Mr. Kapp says the loss will be £1,150 a year, the chairman of the Lighting Committee says it will be a couple of hundred or so. As the ratepayers will have to find the money, I hope the chairman of the Lighting Committee will make his prognostication good. If so, everybody will be pleased."

Coventry.—The following report of the Electric Lighting Committee was carried at the last meeting of the Coventry City Council: "The committee considered modified schemes and estimates of working expenses, submitted by the Brush Electrical Engineering Company, Limited, Messrs. S. Z. de Ferranti, Limited, and Messrs. Hammond and Co. They read letters of Messrs. Siemens Bros. and Co., Limited, and Messrs. Crompton and Co., Limited, and ordered that the committee do visit a station equipped by each of the above-named firms, and that the town clerk be instructed to communicate with them as to the towns to be visited."

Bournemouth.—At the Bournemouth Town Council meeting last week, it was agreed that permission be granted to the electric light company to lay underground mains in the following roads: Durley-road, from Poole-hill to Durley-gardens; Wooton-gardens, Old Christchurch-road, from Yelverton-road to The Quadrant; Fir Vale-road, from Old Christchurch-road to the Grand Hotel. On the motion of Councillor Moore, seconded by Councillor Offer, it was resolved that the Local Government Board be asked to give their immediate sanction to the loan of £800 required for public lighting, as the time of year had arrived when this lighting was necessary for public safety.

Aldershot.—At the Aldershot Local Board, the Electric Lighting Committee reported that letters from Mr. J. Beaumont and Mr. F. J. Beaumont, and a petition from ratepayers as to obtaining electric light for the town, were submitted and discussed. It was resolved, on the proposition of Mr. Darracott, seconded by Mr. Brown, that the committee did not recommend any concessions being granted to anyone, and they recommended a provisional order being applied for by the Board to carry out. The chairman, in answer to Mr. May, said the object of the committee was to prevent other people gaining a monopoly for supplying electricity, so that the Board could obtain the powers to make such a supply themselves. On the motion of Mr. Crismas, seconded by Mr. Darracott, the report was adopted.

Exhibition at Whitehaven.—Messrs. Ramsay Brothers, of the Phœnix Engineering Works, Albion-street, Whitehaven, have just completed an installation of electric plant, to supply light to their establishment in place of gas. The change was announced with conspicuous publicity, on New Year's Eve, by lighting up the Whitehaven Market-place by a powerful arc light, brilliantly illuminating the whole of the Market-place; and the works being open to the inspection of visitors, a large number of persons availed themselves of the opportunity of seeing the new light. The power is obtained from a gas-engine, and there are about 50 incandescent lamps from 8 c.p to 200 c.p. The large arc lamp in the Market-place is of the Brockie-Pell type, 6,000 nominal candle-power. Messrs. Ramsay have also an electric motor for working a pump. The installation has been carried out by Mr. Watson Bell, of Whitehaven, and in consequence of the intended public installation of light has created the greatest interest.

New Zealand.—The following extract from the New Zealand Government Report, 1892, by Mr. Gordon, Government inspector of mines, referring to the Round Hill Mining Company's work, will show that the use of the electric light by this company is appreciated: "The company have also erected one of Crompton's dynamos for lighting purposes, so that they can work at night. They use two lamps, each arc of 3,000 c.p. The motive power for driving the dynamo is supplied by a Pelton wheel 3ft. in diameter, and only a ¾in. nozzle is said to be used, which would be capable of discharging about 27 cubic feet of water per minute, allowing that the hydrostatic head was equal to the hydraulic one, which is not likely. The theoretical horse-power employed would be about 17, or, deducting an allowance for friction, about 11 h.p. may be used in generating the electricity." We might add to this that a number of incandescent lamps were sent out for use in offices, etc., and that the manager says that the actual horse-power required is under 8 h.p.

Blackpool.—There has been some alleged "jobbery" in the letting of the tender for the laying of the pipes for the electric mains at Blackpool, and an animated discussion took place at the last Council meeting. Mr. Councillor Dickinson submitted at considerable length that the tender of Mr. Lewtas for £663 should be accepted, as it was the lowest. The Electric Lighting Committee had provisionally accepted Mr. Taylor's tender, £902, and, considering the difference was £240, it was thought better that the committee should reconsider their decision. They did so, and proposed that as there was this difference the best way would be for the borough engineer to carry out the work and keep accurate accounts of the cost. This will be done. The Council, we hear, are pushing on with the preparations. Brockie-Pell double-carbon arc lamps are to be adopted for the street-lighting. The Mayor, Mr. Councillor Pearson, the town clerk, and the borough electrical engineer have been instructed to wait upon the Local Government Board to urge the necessity of an early sanction being given to the proposal of the Corporation to borrow close upon £30,000 for the purpose of extending the electric lighting system of Blackpool.

St. Louis Electric Railway.—The promoters of the Chicago and St. Louis electric railway project are trying to secure the endorsement and financial aid of Congress by means of a Bill which provides that the company shall be allowed to import, duty free, certain electrical apparatus and machinery to be used in the construction of the road, and that the Postmaster-General shall make a contract with the road for carrying the mails for the period of 10 years, provided the minimum rate of speed is 100 miles an hour. The company also guarantees to furnish electric power to farmers and others along the line at reasonable rates. The Bill is entitled a measure for encouraging the construction of electric railroads, "to facilitate the rapid transportation of the mails, to promote the interest of commerce and travel, and to aid in demonstrating the feasibility of the distribution of electrical power for agricultural and other purposes along the line of electric roads, and especially to aid in the construction of the proposed electric railroad between Chicago and St. Louis by the Chicago and St. Louis Electric Railroad Company, and to secure to the United States Government the use of the same for postal, military, and other purposes."

Aluminium.—The electric manufacture of aluminium seems to be a profitable business, for the Société d'Aluminium, of Neuhausen, announce a profit for their last financial year of 300,952f. At the same time there has been a fall in price from 1,900f. to 625f. per 100 kilos. This reduction of price has resulted in a great increase of output, far more than balancing the lessened price. The sales at the commencement of the year were at the rate of 56,000f. a month, and towards the end of the year rose to 130,000f; after deducting depreciation and interest, a net profit of 166,577f. was made. The total power in the works used is 2,100 h.p. Numerous industrial applications are now being made of aluminium, the greatest demand being for use with iron and steel, as alloy. Aluminium is used for waggon sashframes, portable pumps, pleasure-boats, frames for clockwork, lithographic plates, and even as a substitute for slate-pencils, besides innumerable ornamental purposes. Aluminium-bronze is largely used for military purposes, and in the construction of torpedoes. For electric wires it is as strong as, and of greater conducting power than, silico-bronze wire. The Neuhausen Aluminium Company now produce 20 tons of pure aluminium per month.

Letham Grange Estate. — For some time past extensive improvements and alterations have been in progress on the Letham Grange Estate, near Dundee. Amongst these is an installation of the electric light. Motive power is obtained from a Babcock and Wilcox tubular boiler, which, under 90lb. pressure, is capable of driving the engine at 285 revolutions per minute. The engine is of the single-cylinder vertical type, of 12 h.p. nominal, and is fitted with all the latest improvements. The current is produced by a Victoria compound self-regulating dynamo, capable of developing 60 amperes at 160 volts, and of maintaining 116 16-c.p. incandescent lamps. The latter are of the Edison-Swan type. The installation is fitted up on the parallel system, and, in addition to affording light to the mansion house, also illuminates the riding school, the stables, the dairy, and other offices. The accumulator, placed in the basement of the mansion house, consists of 52 cells of the L type, E.P.S. The arrangements for the lighting of the mansion house are most complete. The riding school is illuminated by means of four 100-c.p. lamps, and the stables, byres, dairy, etc., are also capable of being suitably illuminated. Special precautions are adopted to remove the risk of fire in the mansion house and throughout the other buildings where the light is introduced. The installation, which was carried out by the Brush Electric Light Company, has been executed at a cost of about £2,000.

Cardiff.—At the special meeting of the Cardiff County Council on Monday the Electric Lighting Committee reported that the town clerk had been authorised to apply to the Local Government Board for sanction to the borrowing by the Corporation of the sum of £32,500, for the purpose of erecting an electric lighting station, purchasing and fixing the necessary plant, and laying high and low-tension mains, transformers, and fittings, for the lighting of the streets mentioned in Schedule 2 of the Cardiff Electric Lighting Order, 1891, by electricity. The application (the report added) had been made without waiting for the confirmation of the Council. Councillor F. J. Beavan said this was a very dangerous precedent to establish. How did the committee know the Council would sanction their application for a loan of £32,500? The Mayor pointed out that the Council was already committed to the scheme. It was most important that the work should be proceeded with without delay—that the tenders should be let and employment given in laying mains to many men who were now unemployed. The time was limited, but the matter could be easily stopped if wished. Councillor Ramsdale put a question bearing upon the agreement with Mr. Massey, the consulting electrical engineer. The Mayor, in reply, said the principle of the agreement had already been approved by the Council—namely, 5 per cent. commission to be paid to the expert. The minutes authorising the application were adopted.

The "Umbria" Accident.—The Electrical Company, Limited, of 122 and 124, Charing Cross-road, write to us with reference to the "Umbria" accident as follows: "The accident which recently befell the ss. 'Umbria' through the cracking of her propeller shaft, and the heroic efforts on the part of her engineers, points to the conclusion that our magnificent Atlantic liners are not sufficiently equipped with appliances which in case of need should prove a great boon to steam navigation. It is impossible to carry a well-equipped engineer's shop on board such a vessel. Moreover, ordinary machine tools cannot be readily moved about and applied in confined spaces However, since every large steamer is now supplied with electric light machinery, it would be easy to carry the current to a most out-of-the-way corner of a ship and utilise it for actuating tools run by electric motors. A portable electric drill, for instance, could readily have been used for boring the holes in the shaft of the ss. 'Umbria,' and the task could have been accomplished in one-fifth of the time with very little exertion on the part of the engineers. Such a drill can be used in confined spaces where there is scarcely room for a man to stand in. Many of these appliances of various power and demensions are in use in engineers' shops, and they prove an immense saving. Instead of bringing a boiler, cylinder, shaft, or any other heavy piece of machinery into the vicinity of a fixed machine, portable drills are carried to the spot of application, and no other connection but a pair of wires is necessary to convey the motive power from the generator to the motor. These machines are efficient and cheap, and they ought to form part of every steamer's tool stores. We have supplied a number of them to various engineering works, and feel convinced that marine engineers and shipowners will consider them an absolute necessity as soon as their attention is called to the fact that such useful labour-saving appliances are available. There are numerous mechanical operations being continually performed on board steamships which involve the most laborious hand labour, whereas we have the means within the smallest compass of doing the work of a dozen men, with accelerated speed, through the medium of electricity at a nominal cost." We certainly concur in the idea expressed that the great ocean steamers should carry electric tools, as these are instantly available in case of accident and in any part of the ship.

Bombay.—The Standing Committee of the Municipality of Bombay has been considering the estimates for gas lighting at the present rates of the gas company's contract, which will expire on June 30 this year. Three alternative schemes were proposed, which would cause respective savings of 6,069 rupees, 57,662 rupees, or 44,513 rupees, on sanction being accorded to the alternative schemes—viz.: (1) for renewing the gas company's contract for a further long term on expiration of the present contract on June 30 next; (2) for not renewing the gas company's contract on the termination of present contract and substituting duplex kerosene burners for gas lamps giving 20-c.p. lights against the maximum number of 14 as per gas company's contract; and (3) for discontinuing the gas company's contract on the termination of the present contract and partly using duplex kerosene burners of 20 c.p. and partly introducing electric light. In future years the saving would be much greater under schemes 2 and 3, as there would be no expense on gas at all, and the margin would suffice for a large extension of electric lighting. The first scheme was the question of the cost of lighting the city as at present, assuming that the contract with the gas company was renewed on the offered terms on the expiry of the present contract on June 30, 1893. The second scheme was the question of the cost of lighting the city, assuming that from March 1 to June 30, 1893, the city would be lighted as heretofore, and that for the remaining eight months of the year (*a*) all ordinary gas lamps were lighted with kerosene oil duplex burners; (*b*) special and Bray's lamps were lighted with gas or with special kerosene oil lamps; and (*c*) the existing kerosene oil lamps are lighted with duplex burners having only one wick lighted. The third scheme was the question of the cost of lighting the city, assuming that from 1st March, 1893, to 30th June, 1893, the city was lighted as heretofore, and that for the remaining eight months of the year (*a*) Esplanade-road, Hornby-road, Elphinstone Circle, Church Gate-street, Rampart-row, and Apollo Pier are lighted with electric arc lights; (*b*) the remaining ordinary gas lamps were lighted with kerosene oil duplex burners; (*c*) the existing Bray's lamps were lighted with gas or with special kerosene oil lamps; and (*d*) the existing kerosene oil lamps were lighted with duplex burners having only one wick lighted. The three different schemes ought to be submitted to the Corporation, which would make its own choice in the matter. The opinion of the committee was that in sanctioning the full amount entered in the draft estimate for lighting, 321,410 rupees, and submitting the three schemes proposed by the commissioner, the Corporation itself should discuss and determine the relative merits of those schemes. Bombay is one of the largest cities in the British empire. It is to be hoped that if the electric light is introduced a careful and comprehensive scheme will be adopted.

Glasgow Tramways.—Bailie Paton, in moving the approval of the minutes of the Tramways Committee at the Glasgow Town Council meeting last week, said that the report submitted by the sub-committee had been agreed on after the fullest consideration. So far as the northern district was concerned the cost of overhead electric traction would be £10,000 per double mile for six miles, exclusive of the ground. There was a strong prejudice against overhead wires and poles. The telephone companies and the Post Office authorities had objections, which were almost insurmountable, and considering that £60,000 capital would require to be spent before they could adopt the new system, the committee had come to the conclusion that they would not be warranted in doing so at present. They felt that a good deal could be said in favour of the electric system of traction, but the time was not ripe for bringing the matter before the community. They further found that the route on the busiest part of the city could be converted from the present system to cable lines for about £20,000 per double car mile. The committee thought very highly of that system, but their feeling was that, seeing that they could not touch these lines for the purpose of altering them to cable lines until the expiry of the present lease, there was no use in hurrying the Council to come to a decision. Nothing could be done till they got possession of the lines; and the committee thought that, before coming to a conclusion, they should await further development of the electric and cable systems. In regard to the capital costs, the figures given might be accepted as being correct. So far as the cost of the overhead system was concerned, they had a large number of offers, and there could be no doubt, notwithstanding the articles in the newspapers, that the cost of the overhead electric system would be £10,000 per double mile, and they were not prepared to recommend the adoption of that system Mr. Rankine's estimate of the cost of the cable system was just what was expected. It was not such as should frighten the Council, and probably this was the plan which would be adopted in the long run. Mr. Gray moved that it be remitted to the committee to report as to the estimated capital sum required for working cable tramways on the Parkhead and Whiteinch route, with the annual cost of working, and the corresponding cost and upkeep of the horse haulage system, taking future requirements into consideration. Mr. Mayberry seconded the amendment. The Lord Provost said he thought Mr. Gray should let the matter stand, seeing that the committee practically made no recommendation. Mr. Gray said it was only one short year till 1894, but he was willing to withdraw his motion. The minute was then approved.

Bewdley.—We mentioned briefly last week that proposals had been made at the Bewdley Town Council for the utilisation of the power of the River Severn. The proposal was brought forward by Alderman Baker, who moved the appointment of a committee to consider and report upon the desirability of utilising the power of the River Severn for furnishing the town and neighbourhood with electric light, also to report as to the use of such power for pumping water for domestic purposes and street-watering, and further whether it might not be desirable to sink one or two public wells for the supply of drinking-water, no expenditure of money to be made by the committee until authorised by the Council. He remarked that he did not wish to alarm the Council by bringing forward a motion which might seem to foreshadow a large expenditure of public money, but he had had his attention a good deal turned towards the question of electric lighting, and he fully believed that electricity was to be the light and power of the future, and that what the steam-engine had been in the present century electricity would be in the next. He did not believe even those who had studied the question could measure the very brilliant opening there was for the human race in the knowledge which was being obtained of the extraordinary power of electricity which seemed to exist in the earth and air and every thing they knew of. A small and poor borough like Bewdley ought not to be behindhand in taking advantage of what would prove an extremely beneficent thing for the human race. An enormous volume of water was rapidly flowing past the town continually, and doing nothing for the town, but he believed the power of the river could be utilised so as to be a blessing to the place, and other towns might follow their example. At the last meeting of the British Association a paper was read by some gentleman who had invented a plan by which the power of floating water might be utilised, and also by which the power of tides might be profitably made use of. It was impossible to tell what enormous advantages would accrue to the human race if the great power of tides and river was taken advantage of. It would save the burning of costly coal, and prevent the atmosphere stinking from the fumes of fires. It was most important in a health and pleasure resort like Bewdley that the air should be kept thoroughly pure, and he thought it most advisable that a committee should be appointed to go fully into the questions he had suggested He could promise nothing, but the matter was certainly worth consideration, and the advice of competent electrical engineers should be taken as to whether the great power lying at their doors could not be made use of. He knew with regard to the cost of the electric light, that at present it was as dear as gas at 2s. 6d. or 2s. 3d. per 1,000ft,, but where they had gas at 4s. 6d. or 5s. per 1,000ft., it would be cheaper to have the electric light, and they would be able to supply not only the borough but also Wribbenhall and the adjoining districts, which they could not do if they had the gasworks in their own hands, as they would be limited to supply the borough only. If the suggestions he had made could be carried into effect, they would make the very waves of the river which were flowing past useful and serviceable to the town. Mr. Cook seconded the motion. Alderman Tangye said that no doubt power could be got from the Severn, but it would cost at least £20,000. They would have to go 10 or 12 miles north to get sufficient fall. The cost was so enormous that they need not consider the proposal. He stigmatised it as "bosh." Mr. Humpherson wanted to know why Alderman Baker had not proposed the scheme for Birmingham. They had had one of the best electrical engineers to visit Bewdley on the question of electric lighting, and he was offered a free supply of water from the hills for a certain number of years if he thought it was possible that the power thus provided would supply the town with the electric light. He was unable to report favourably on the matter, and was then asked to advise with regard to utilising the power of the river, and he said if Bewdley were 50 times its present size he could not advise any such a scheme, as the expense would be enormous. Alderman Baker, in reply, said they seemed to think that because the matter was considered three years ago and found impracticable, that it was impracticable now, but that showed how ignorant they were as to what had been going on in electrical discovery. He did not pose as having any knowledge on electrical matters. All he did was to suggest that they might make enquiries into the matter, without going to any expense, as to the recent discoveries for utilising the power of flowing water. He had seen at Keswick, which was very little larger than Bewdley, how a fall of 8ft. or 10ft. in a very small stream was sufficient, by being utilised by mechanical appliances to generate electricity, to light the town, and he saw no reason why it should not be done at Bewdley. The resolution was carried unanimously, Mr. Smith voting against it, and the committee was, on the motion of Alderman Baker, constituted as follows: Aldermen Baker and Jefferies, and Messrs. Cooke, C. Crump, Wilson, Oakes, Owens, and Styles.

Burnley: Consulting Engineer and Contractor.—At the monthly meeting of the Burnley Town Council last week, Alderman Collinge moved that, on the recommendations of the Gas and Electric Lighting Committee, the Council appoint Mr. Thomas Parker, of Wolverhampton, as consulting engineer in connection with the electrical installation, at a total fee of £400, to include his services for his preliminary report, and the wages of a clerk of works to attend at Burnley from the commencement to the completion of the installation. Alderman Lancaster seconded. Councillor Lupton protested against the appointment as an absurd one, and moved an amendment that the matter be referred back to the committee. It was a most irregular thing to engage a man to supervise his own work. Mr. Parker's firm was supplying the dynamos and accumulators, and so the Corporation were paying a man to see that he did his own work right He wanted to know who was going to look after Mr. Parker, seeing that he was contractor, consulting engineer, and clerk of works. The whole thing was without precedent, and he challenged the committee to give such a case. He felt doubtful when it was stated at the Local Government Board enquiry that Mr. Parker was tendering his advice for nothing, and now it was evident they were going to pay two or three times over for this "gratuitous" advice. Alderman Lancaster said that, after the many failures which had attended electric lighting schemes in other boroughs, the committee were anxious, above all things, not to be connected with a failure, but to get the very best advice they could and the best materials. From the information they could get in various quarters, they found that Mr. Parker was looked upon as the foremost electrical engineer in England. They were spending £16,000 now, and this might eventually reach £25,000. They were, therefore, anxious to take every precaution against failure, and considering the importance of the work and the risk involved, £400 was not an excessive amount, seeing that it covered his travelling expenses, reports, and wages as clerk of works. The latter might be put down at £6 or £7 a week for 20 or 30 weeks, which did not leave much for his personal advice. It was true the Electric Construction Corporation, of which he was manager, had tendered for the work. They tendered for the whole undertaking, as did two or three other large firms. But the committee found that by dividing the work, and taking the lowest figure in each contract, for the several parts of the scheme they could save about £2,000, and this they had done. The Electric Construction Corporation sent the lowest tender for dynamos and accumulators, and they had given them the work. The committee had carefully considered Mr. Parker's position, but, everything taken into account, they did not think they could do better. They might do without a consulting engineer, and they might have the whole thing a failure, but in such a risky undertaking the committee desired to take every precaution against incurring the fate which had attended several other corporations in this matter. Councillor Holmes objected to the employment of a contractor as clerk of works to see that his own work was done properly. It was wrong in principle, and he should like to know what were the special circumstances which had led the committee to take such a course. Alderman Lancaster had said the lowest tender had been accepted. No doubt it would pay Mr. Parker to send in one a little lower than the rest if he was to have £400 for superintending the work. Alderman Lancaster said the tender of the Electric Construction Corporation was not the lowest for the whole scheme Their item for dynamos and accumulators was the lowest (£2,000) of the lot, and this alone was accepted. Alderman Collinge admitted that the position of Mr. Parker was an unusual one, and a very undesirable one as a general rule, but there were special circumstances in this case. The committee were pestered with offers from gentlemen to act as consulting engineer, but on enquiry they found nearly the whole of these were the agents of certain companies, and had their own ends to serve. It was very difficult to get a man who would give them disinterested advice. In Mr. Parker they believed they had got the best available man, and for the sake of a tender of £2,000 they did not think it advisable to part with him. It was only one-eighth of the whole, and so high was the reputation of the firm with which Mr. Parker was connected that the committee had every confidence this branch of the work would be efficiently done. The committee had two courses—either to let the contract to one firm who would be responsible for the whole undertaking, or to divide the work and have a consulting engineer. By splitting up the tender they saved £2,000, and Mr. Parker would undertake the responsibility of the whole work, and see that it was completed in a satisfactory way. Alderman Burrows considered the position of Mr. Parker wrong in principle, if only a shilling were involved in the contract. He thought the committee should see if some other arrangements could not be made. Councillor Williams said the principle was rotten from beginning to end, but still only £2,000 was involved out of the £16,000, and under the circumstances he did not think the Corporation would suffer by it Alderman Sutcliffe asked if, from the present time, Mr. Parker's company would cease tendering for any work that might be required to be done. Councillor J. S. Sutcliffe asked if Mr. Parker's company would guarantee the success of the whole undertaking. Councillor Parsons said it was only after careful enquiry he came to the conclusion to engage Mr. Parker. His position as consulting engineer was totally separate from his position as manager of the firm who were supplying some of the plant, and the committee would take good care that the plant supplied by the Electrical Construction Corporation was carefully inspected. They would make a great mistake indeed if the amendment was adopted. Alderman Lancaster, in answer to Alderman Sutcliffe, said the specifications all originally came from Mr. Parker. They had a large number of applications to electric light in different parts of the borough, so it was necessary to revise some of them. Alderman Collinge said Mr. Parker did not want the position of consulting engineer, but the committee wanted him to have it. Even if they dispensed with Mr. Parker as consulting engineer, his bill for the other work would not be far off £400, and then they would have another man to pay. Only five voted for the amendment, and the appointment of Mr. Parker was confirmed by an overwhelming majority.

Hanley.—A special meeting of the members of the Hanley Town Council was held on Wednesday last week on a requisition signed by five members for the purpose of considering the position of the Council with regard to the electric lighting provisional order. The mayor (Alderman E. J. Hammersley) presided. Councillor Palmer said he had taken up this subject from the fact that a number of members who voted for the lighting of the town by electricity and the accepting of estimates did so on the understanding that the Council was obliged now to have electric lighting. As one gentleman described it, "We have an Act of Parliament, and are bound by it." He proposed to show that this was an erroneous view, and also to show that the cost would be such that the electric light could not be profitable. The Mayor asked the speaker to confine himself to the provisional order, on which subject the meeting was called. Councillor Palmer said he hoped he should not be burked in what he had to say, but should be allowed some latitude. He also hoped they would sink all personal feeling, and mentioned that General Crozier, who had lately held a Government enquiry on the subject at Hanley, asked to be informed of the result of that meeting. He pointed out that there was a clause in the provisional order which gave the Council power, instead of spending a large sum of money in putting in an installation themselves, to make satisfactory arrangements with any company to do the work, and the Council could take over the concern on terms agreed upon when it suited them to do so. This was being done at the present time in other towns, and he therefore said they were not obliged to instal the electric light themselves. The more he went into this question, and he had investigated it thoroughly, the more he was convinced it would never pay in Hanley. Newcastle-on-Tyne, with its large ratable value and mechanical knowledge, had not thought fit to tax the ratepayers with electrical experiments, but had let the privilege to two companies, who were supplying the light satisfactorily and at a cheap rate. The Corporation of Bradford were supplying the energy in their town, and the electric light had been installed in the Free Library and Museum, the result being that whereas in 1891 the cost of lighting by gas was £244. 15s. 7d., the electrical lighting of the same buildings last year cost £474. 11s. 4d. Quoting from the prospectus of the Brush Company, he contended that there ought to have been £700 more set down in the estimates for deterioration, while the fitting of the public buildings and the purchase of necessary instruments, which were not mentioned in the estimates, would cost £4,000. He then argued that there was no general probability of the electric light being used by manufacturers in the town. Alderman Ridgway had a nice installation in his flour mill, but its main advantage was the removal of risk of explosions. Messrs. Meakin had also installed the light in their packing-house, but from their experience they were not inclined to extend it to other parts of the manufactory. Mr. Alfred Meakin, of Tunstall, had also used the electric light at his works, but when he started the Highgate Pottery he did not adopt it there, because on going into the matter thoroughly he found the advantage decidedly on the side of gas. Mr. Meakin wound up by expressing the opinion that the Hanley Town Council was making a great mistake in proposing to supply electric lighting for manufactories. He (Councillor Palmer) also argued that there were no large consumers who desired the light, and said before they could begin to earn money they would have to attain to a revenue of £3,000 a year. Then, if they made the scheme profitable, all they could earn was 5 per cent., all profits over that amount being applied to reducing the cost to consumers. He admitted frankly that if they could get the energy taken in sufficient quantities the scheme would pay its way, but he believed that as they had no underground warehouses and workshops to light, the number of hours for which the illuminant would be needed would not be sufficient to make it profitable. Having pointed out that the cost of an arc light at Hanley was estimated at £15, while it cost £42 in Newcastle-on-Tyne and £30 in Eastbourne, he called attention to the rapid growth of the liabilities of the town, which he said, including the School Board indebtedness, would stand (if this scheme was carried out) at £227,767, whereas the ratable value was £173,000. He moved that the Council invite tenders from any company or person for the transference to them of the powers contained in the Hanley electric lighting order. Councillor Ball thought it would be well to put it on one side for 10 years. Councillor Palmer said he had no objection to move a resolution to ignore the whole thing. Councillor Granville seconded the motion, on the ground that this was not a fit and proper time to go into an expenditure of £21,000, which might be £50,000 before the scheme was finished. The Mayor said the resolution was not in order, because the Council, on the 10th of December, 1889, resolved not to entrust any further powers for artificial lighting into the hands of a company. Councillor Palmer said he would give notice for the rescinding of this resolution. Councillor Harrison moved that the Council did not consider it desirable to reopen the question. Councillor O'Keeffe seconded the motion, and said that no town had suffered more from monopolies than Hanley. He regarded the electric light as the light of the future, and urged that it would be an absurdity for the Council now to stultify itself after passing a unanimous vote in favour of the scheme. Alderman Cooke said there was no reason why the electric light should cost the ratepayers a farthing, as any loss at starting could be carried to a suspense account. Councillor Bentley moved, as an amendment, that the Council considered the evidence given at the recent enquiry insufficient to justify them in borrowing money to carry out the scheme. Hundreds of families in Hanley were, he asserted, suffering from want, and if they went on increasing their indebtedness at this rate there would soon be a liability of a quarter of a million, so that there would be nothing but direct bankruptcy to face. Councillor Coates considered that it would be a great mistake to lose the present opportunity of introducing a superior light into the town. Alderman Ridgway said this was not a matter that had been sprung suddenly upon the Council. It had been discussed at 64 meetings, and 20 times the Council had resolved to have the electric light, and that it should be introduced by themselves in preference to a company. Having reiterated its opinion so frequently, and obtained so favourable a contract, it seemed to be out of the range of possibility that the Council should relinquish the chance they had and hand it over to some third-rate company. Speaking of the electric light at his mill, he said the workmen derived greater comfort, the high temperature of the rolling-room when lighted by gas had been reduced, and his experience was that electricity was infinitely cheaper than gas. After some further discussion the Mayor asked for a vote on Councillor Harrison's motion against reopening the question, which was carried by fifteen votes to eight.

PROVISIONAL PATENTS, 1893.

JANUARY 2.

36. **Improvements in electrical indicators.** Frank Villiers-Stead, 44, Gutter-lane, Cheapside, London.

JANUARY 3.

78. **Electromagnets.** Richard Varley, jun., and Frank Cazenove Jones, 5, John Dalton-street, Manchester. (Complete specification.)

122. **Improvements in fastenings for securing metal arms or brackets to telegraph poles** Siemens Brothers and Co., Limited, and George William Perry, 28, Southampton-buildings, Chancery-lane, London.

133. **Means for obtaining electrical resistances.** Henry Newman Lawrence, 36, St. Martin's-lane, London.

140. **Improvements relating to storage batteries and electrodes therefor.** George Washington Harris, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 4.

172. **Improvements in and relating to arc lamps.** Rankin Kennedy, 96, Buchanan-street, Glasgow.

206. **Improvements relating to apparatus for producing light by means of alternating electric currents.** Sir David Lionel Salomons, Bart., and Lazarus Pyke, 433, Strand, London.

212. **Improvements in d'plex and multiplex telegraphy.** Walter Langdon-Davies, Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 24, Southampton-buildings, Chancery-lane.

222. **Improvements connected with electric belts and bands for curative purposes.** Noah Mitchell, 166, Fleet-street, London.

229. **Improvements applicable to dynamos.** Henry George Read, 4, St. Ann's-square, Manchester.

JANUARY 5.

236. **An electric railway signal for use in fogs or any other time.** Arthur Smethurst, Brookfield Cottage, Barton-on-Irwell, Manchester.

238. **Improvements in and relating to the Deprez-d'Arsonval galvanometer.** Herbert Watson Sullivan, 29, Ladbroke-square, Notting Hill, London.

246. **Improvements in the method of casting frames or supports for electric battery plates or elements, and the apparatus therefor.** Edgar William Timmis, Stone Hall, Oxted, Surrey.

257. **Improvements in apparatus for insulating electric wires or conductors.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery-lane, London.

258. **Improvements in means or apparatus for use in the application of electricity for heating liquids and in means or apparatus for manufacturing same.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery-lane, London.

259. **Improvements in the heating of surfaces for the drying, heating, or other treatment of paints, oxides, or other matters by the aid of electricity, and in the means or apparatus employed therein.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery-lane, London.

JANUARY 6.

336. **Improvements in or relating to lightning conductors.** Alfred Julius Boult, 323, High Holborn, London. (Gustave Walch, Germany.) (Complete specification.)

JANUARY 7.

344. **An apparatus for heating water or other liquid by means of electricity.** Bernard Page Scattergood, 41, Park-square, Leeds.

358. **A combined knocker and electric bell whereby an alarm is given should an attempt be made to remove the knocker.** Joseph Rippingham, 9, Westland-road, Dublin.

387. **A combined electric launch and sailing vessel.** Kerbey Daveron Bowens, 47, Lincoln's-inn-fields, London. (Complete specification.)

391. **Improvements in the manufacture of elements for electric or secondary batteries.** Emmanuel Hancock and Augustus John Marquand, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1879.

4903. **Telephones.** Scribner. (Second edition.)

1891.

15749. **Electric arc lamps.** Akester.

17352. **Motors** Baldensperger.

22429. **Varying resistances of electric circuit.** Singer.

1892.

568. **Electric incandescent lamps.** Bamberg.

1786. **Tanning by electricity.** Pinna.

2393. **Using electricity as medicinal agent.** Griggs.

2690. **Electric arc lamps.** Tipping.

2722. **Electric switches.** Shepard.

3291. **Tubular electrical conductors.** Payne.

3300. **Connecting electrical conductors.** Barley.

7095. **Electric arc lamps.** Sugden and Sandy.

7237. **Commutators for dynamo-electric machines, etc.** Paterson and Furneaux.

11779. **Carbons for electric arc lamps.** Braun.

19655. **Heating by electricity.** O'Neill.

19671. **Conducting electricity.** Pollard.

19768. **Thermometers for closing electric circuits.** Westbrook.

20621. **Electric burglar alarm.** Wilson and Schwab.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5 3	5½ 3¾
London Electric Supply	5	⅞
Metropolitan Electric Supply	—	6¾
National Telephone	5	4¾
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	6

NOTES.

Theatre Searchlights.—Small electric searchlights are being substituted for the old limelight on the stage in several of the London theatres with satisfactory effect.

Institution.—The inaugural address of the President of the Institution of Electrical Engineers, Mr. W. H. Preece, F.R.S., will be delivered next Thursday, the 26th, at 8 p.m.

Chamber of Commerce.—A special general meeting of the London Chamber of Commerce will be held at noon to-day (Friday), at Botolph House, Eastcheap, to consider the new scale of railway rating.

Mining Lamps.—There is a rumour, which we believe to have a foundation, that one of the largest mining managers in the Midlands is about to systematically test the use of portable mining lamps in fiery mines.

Amateur Union.—An Amateur Electrical Union has been formed in America, the secretary being G. Clifton Minor, of Baltimore. The association is to have a paper and a library of their own, with lectures from electrical experts.

Electrical Slang.—The expressions, "Out of your depth," or "You don't know what you are talking about," seem to be giving way amongst boys in America to the simile, "Ah! yer trolley's off!"—an expressive enough phrase for a stick-in-the-mud.

Electric Horse Ornaments.—The Jaghirdar of Arni has had two little incandescent lamps fixed on the harness between the ears of his carriage horses, the current being supplied by a small battery inside. The novelty attracts much attention from the populace.

Milan.—In connection with the International Electrical Exhibition to be held at Milan in 1894, it is proposed to offer a prize for the most important electrical invention or discovery, especially relating to the transmission of energy to a distance, and its distribution and transformation for industrial uses.

Aluminium.—It is proposed to call the metal aluminium by the name "al" simply. As the metal becomes more widely used, as it must do, as its good qualities get known, a short term will be required, the present one being a large mouthful. Al will possibly be found a suitable name; it is distinctive, and as short as tin, zinc, or gold.

Lathe-Feeding by Electricity.—In certain engineers' shops the feed of the large lathes is controlled by electricity for turning tapers or work of irregular outline, a contact energising an electromagnet being found to act with satisfaction. An electric contact is also used to indicate when the work is set exactly in position.

Lighthouse Communication.—The Royal Commission on lighthouse communication with the shore has concluded its interim report, which will be laid before Parliament on the 31st inst. It will be proposed as an experiment that some of the more important lightships should be connected with the shore by electric cables.

"Recollections of Werner von Siemens."—An English translation of the "Recollections of the Life of the late Werner von Siemens" will be published shortly by Messrs. Asher and Co., of 13, Bedford-street, Covent Garden. The German original, published in December last, ran most successfully through two editions in the course of a few weeks.

Books Received.—We have received "The Standard Electrical Dictionary," by T. O'Connor Sloane (Crosby Lockwood and Co.); "Electrical Experiments," by G. E. Bonney, with 144 illustrations (Whittaker and Co.); and "How to Manage the Dynamo," by S. R. Bottone (Whittaker and Co.), a handbook for ship engineers, dynamo-men, and electroplaters.

Automatic Telephones.—A complete installation of the Strowger automatic telephone exchange is to be exhibited at the Chicago Exhibition. This system, doing away as it does with all operators, is creating the greatest interest amongst telephone men. The exhibitors will be able to connect themselves together on this system, and so thoroughly test the apparatus on a practical scale.

Death.—A *Times* special telegram, dated Jan. 15, says: "The death is announced of Mr. Edward Charles Cracknell, superintendent of telegraphs in New South Wales. In 1855 he went out from England to South Australia to act as assistant superintendent of telegraphs in that colony, and three years later he transferred his services to New South Wales. In 1861 he became telegraph superintendent, and held the position up to the time of his death."

Enamelled Iron.—Shades of enamelled iron being a very common article of electrical commerce, perhaps some of our readers may like to learn how the process is carried out. The Francois and Bertin process consists, according to the *Revue Industrielle*, in dipping the iron plates into an enamelling liquid composed of: borax 24 parts (by weight), soda salts 6, boric acid 15, washed sand 25, felspar 12·5, saltpetre 3·5, fluor spar 3 parts. The plates are then dried and fired. Colouring is obtained by adding metallic oxides.

Azores Cables.—The *Bulletin de l'Electricité*, which seems lately to have dropped completely out of the running in technical literature, publishing little but second-hand notes, has suddenly developed a great interest in the proposed French Azores submarine cable, and in a leading article discusses the influence of M. Jules Roche in launching this enterprise. The writer thinks the work should be in the hands of commercial men, and not left to bankers and company promoters. The article is to be continued.

Telephote.—An illustration of Mr. Broughton's telephote for signalling at sea, which we described last week, is given in the *Scientific American* for January 7. The dot and dash signals shown by lamps is an effective way of signalling, and as the combinations are automatically made by pressing a lettered key, any ordinary person can send messages, though, of course, it requires a trained operator to read the signals. As many as 72 letters a minute have been sent, and signals can be read, it is stated, by this apparatus further than by flags in the daytime.

Free Police Electric Communication.—At a meeting of the Police Committee of Forfarshire held recently, having reference to the establishment and use of telephones between populous places and outlying rural districts with telephone call offices in the county, it was announced that the committee had arranged to pay all communications between the public and the police giving police information. A similar arrangement was recently in force all over the country for facilitating the giving of information under the Contagious Diseases (Animals) Acts.

Summary.—A comprehensive summary of the progress of electrical engineering during the past year, given at the commencement of the new volume of the *Engineer*, directs attention to factory driving by electricity. So far the engineers on the Continent have used this method more than has been the case in this country. Perhaps the finest example, says our contemporary, is that at Herstal, near Liège, in Belgium, where the new small-arms factory is entirely driven by electricity. The Chemin de Fer du Nord also employs this method with success. A great development in the electrical branch of engineering is looked for in the coming year.

Dungeness Lighthouse.—The lighthouse at Dungeness has been the subject of an illustration in the *Daily Graphic* recently. It is interesting to learn that since 1792 the 100 yards from low-water mark have increased to 500 from high water, the growth seawards being three yards a year. Oil is used in the lighthouse, but electric light has been in use experimentally, though there was a common complaint that it was too brilliant and dazzling, and that vessels could not accurately ascertain their bearings by it. Moreover, it was said that the coastguards nearing one another on their beats actually came into collision before aware of each other's presence. As Dungeness is easily accessible, further experimental trials will probably be made at this lighthouse.

Labour Department.—The approval by the Government this week of the formation of a Labour Department of the Board of Trade is an event of some importance in the engineering world. The main functions of the Labour Department will be to collect, sift, and distribute the fullest information on the labour market. Correspondents will be placed at the various trades and commercial centres of the country, and the department will have representatives, mostly the British consuls, in the various foreign countries. Mr. Mundella, as President of the Board of Trade, is responsible for the scheme, and the wide-spreading interests involved should make it desirable for the Chambers of Commerce and other allied bodies to heartily co-operate with the work of the new department.

Silk and Cotton Insulation. — Mr. Thatcher Luquer, C.E., in his thesis for electrical engineering, Columbia College, deals exhaustively with the insulation resistance of cotton and silk-covered wire. This thesis is reproduced in the N. Y. *Electrical Engineer* with diagrams. The author's conclusions are: Silk, shellaced, is the best insulator; plain silk coming next, being very good, although only ·004 thick; double cotton, shellaced, is practically as good as plain silk for voltages below 120 volts, but is over twice the thickness. It is advisable to use shellac on all cotton-covered wires, taking care to dry the coils. It may be interesting here to add that shellac is almost the only substance that does not very materially deteriorate when overheated and blackened.

Teaching University for London.—The Convocation of the University of London on Tuesday adopted a scheme for the reconstruction of the university, embodying the assimilation of the institution to the older universities, while preserving its Imperial character. It allows for the passing of candidates not residing in London as at present obtains, and also provides for the introduction of a Faculty of Divinity. This part of the scheme was greatly objected to by Dr. Silvanus Thompson and Mr. A. W. Bennett, Dr. Thompson moving that the names of those voting for a theological faculty should be entered on the minutes. The scheme has still to go before the Senate, but it is possible in its present form it may be at length passed, and London may have what it has so long been without—a true teaching university.

Guitar or Banjo-Playing by Electricity.—An ingenious adaptation of electricity to music playing is described in the Western *Electrician* as the design of Mr. W. H. Gillman, of Boston. A guitar or banjo has electromagnets fitted so as to press on the frets when energised, and a plucking arrangement strikes the strings. The movements are controlled by a moving strip of paper run by an electric motor, through guideways of a contact-maker, the paper being previously stamped out in dots and dashes corresponding to the tune. Well, well! we suppose they do these things better in Boston, but as for ourselves we prefer the skill and delicacy of a Spanish player. The tendency of this century seems to be to leave skill of hand to grind out music and painting by machinery—but, as Ruskin says, you can get nothing but dust by mere grinding.

Accumulator Traction.—An electric car is being run experimentally on the storage battery system on the Ninth Avenue-road in New York. The car weighs 6½ tons, carrying 144 cells each of 27lb., having a capacity of 140 ampere-hours, at an average discharge of 25 amperes. The gradients on the three miles are heavy, one being no less than 6 per cent. for 200ft. On the up trip 31 amperes are used; a current of 75 amperes may, however, be taken. The time is 24 minutes 50 seconds. On the down trip, mostly descending, the average current is 19 amperes, and the time 22 minutes 30 seconds. The entire double trip has been done in 47 minutes 20 seconds. The batteries are made by the Acme Storage Battery Company, and the company claim that the cost of running is 4½d. per car mile, though, as no figures are given, this is evidently only an estimate.

Electricity in the Rockies.—An exciting paper was read before the Royal Meteorological Society on Wednesday on "The High Altitudes of Colorado," by Dr. Williams, who quoted some striking examples of electrical phenomena witnessed on Pike's Peak (14,147ft.) by the observer of the U.S. Weather Bureau. During a violent thunderstorm flashes of fire and loud reports, with heavy showers of sleet, surrounded the summit in all directions, and brilliant jets of flame of a rose-white colour jumped from point to point on the electric wire, while the cups of the anemometer, which were revolving rapidly, appeared as one solid ring of fire from which issued a loud rushing and hissing sound. During another storm the observer "was lifted off his feet by the electric fluid," while the wristband of his woollen shirt, as soon as it became damp, formed a fiery ring around his arm.

Aluminium-Plating.—Much interest was aroused by the account recently given of the work of electroplating the ironwork of the Philadelphia City Hall tower with aluminium. It will take, it is thought, three years to complete the work, as the aluminium-plating is very tedious work, and there is a surface of 50,000 square feet to be covered. The huge tanks were erected in April last, and one-eighth of the whole work has been accomplished. The iron is first given baths of caustic soda, of dilute sulphuric acid, and of copper solution in immense tanks, 28ft. long, 4ft. wide, and 5ft. deep, holding 3,800 gallons. The aluminium tank holds about 7,000 gallons, and receives the work after it has been dipped. Nearly 10 tons of aluminium will be required to coat the whole surface. The current is supplied by four large dynamo, and the buildings have been specially erected for this undertaking.

Old Students' Association.—A meeting of the Old Students' Association will be held at the Central Institution, Exhibition-road, S.W., on Friday, January 20, at 8 p.m., when a paper will be read, entitled "Central Station Notes," by W. Brew and P. G. Ledger, members, which will be fully illustrated by optical lantern. Synopsis:—Boilers: coal consumption, special steaming for short periods, feed water, specimens of boiler tubes from breakdowns. Engines: continuous running, efficiency, direct coupling, governors, experimental results, indicator cards. Dynamos: parallel working with different types of machine, lag of induction in large machines, experimental results, effects of form of characteristic on compound machines in parallel working. Switchboards: instruments, etc., regulation, practical and reliable standards. Supply: theatres, etc., curves from Royal English Opera House, motors in central-station working.

Rotary-Current Plant.—One of the most complete illustrated descriptions ever given in a foreign technical paper is published this week in the *Elektrotechnische Zeitschrift* (January 13) of the multiphase-current central station at Lauffen for supplying the town of Heilbronn. As this is the first, and at present only, instance of the utilisation of the rotary current for central-station distribution, additional interest is added to the presentation of the plans and drawings, carried out by the Oerlikon Company to the plans of Herr Oscar von Miller, of Frankfort. The work was commenced in September, 1891, and the station was started on January 10, 1892. There are now 9,600 lamps of 16 c.p. supplied from this source, besides rotary-current motors. The current is generated at Heilbronn at 50 volts, 4,000 amperes, and is transformed up to 5,000 volts. It is reduced to 1,500 volts in the primary transformers, and again to ordinary pressure at the secondary transformers for the lamp circuits.

Painting by Electricity.—New uses and applications for electric motors are coming forward week by week, not the least useful and interesting being that of painting by electricity. One wonders at first how this can be done; but wonder soon changes to admiration of the bold ingenuity of the man who applied the simple process when the apparatus is explained. It seems that the Electricity Building at the Chicago Exhibition wanted painting quickly, so Mr. C. Y. Turner devised a spray paint-brush made of a piece of metal tubing hammered flat, just leaving a slit sufficient to allow the admission of a cardboard. This is attached to a hose, the hose dips in a barrel of liquid paint—"kalsomine"—passing by way of a rotary electric pump, driven by a 5-h.p. motor. The painter seizes the gas-pipe, holds it about 18in. from the surface he is decorating, turns on the tap, and the work is done. Two men on a movable scaffolding can do more in one day with this paint squirt than a dozen men with brushes could manage in a fortnight.

Railway Safety Appliances.—In Major Marindin's report on the Thirsk accident of November last, when nine persons were killed and 39 injured, a paragraph occurs on the use of safety appliances. Major Marindin remarks that there are in existence several combinations of electrical and mechanical appliances, the use of one of which, so long as everything was maintained in good order, would make it impossible for such an accident as this to occur unless a driver were to run deliberately past fixed signals. It is the duty, he says, of all railway companies to adopt, upon their important lines at any rate, some safety appliance which will prevent a mistake made by one signalman from causing an accident. If there be such a machine which has been proved to be reliable, and as some of the inventions mentioned have been in general use for some years upon three lines of railway, and in partial use upon others, and have been found satisfactory, he would strongly urge not only the North-Eastern Railway Company, but other railway companies also to give this question their immediate consideration.

The Electro-Harmonic Society.—A smoking concert will be held on Friday, January 27, 1893, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at 8 o'clock. Artistes: Mr. James Brown, Mr. J. Gawthrop, Mr. David Strong, and Mr. Robert Grice; double bass, Mr. Haydn Waud; pianoforte, Mr. Alfred E. Izard; magical art, Dr. Holden; musical directors, Mr. T. E. Gatehouse and Mr. Alfred E. Izard. Programme—Part I.: Madrigal, "Come, let us join" (Beale), Messrs. J. Brown, J. Gawthrop, D. Strong, and R. Grice; song, "Margarita" (Löhr), Mr. James Gawthrop; pianoforte solo, "Fantaisie—Impromptu" (Chopin), Mr. Alfred E. Izard; song, "Vulcan's Song" (Gounod), Mr. Robert Grice; double bass solo, "Fantaisie" (Waud), Mr. Haydn Waud; song, "But One" (Bevan), Mr. David Strong; magical art, Dr. Holden. Part II: Glee, "Mynheer Vandunck" (Bishop); song, "Good-night, Beloved" (Balfe), Mr. James Gawthrop; song, "A Soldier's Song" (Mascheroni), Mr. Robert Grice; double bass solo, "Air Varié" (Richardson), Mr. Haydn Waud; part song, "I Know a Maiden" (Hatton); song, "The Distant Shore" (Sir A. Sullivan), Mr. David Strong; magical art, Dr. Holden.

Efficiency of Alternating Plant.—The case is stated of an alternating-current station running 1,300 lights from 97 transformers on 1,100-volts circuit, reduced 20 to 1. The instruments are correct, and in a month of 31 days the manager finds he has a primary output equal to 120,490 secondary ampere-hours, while his meter readings sum up to only 72,560. This is the first case in which we have seen the actual figures given. Prof. Harris J. Ryan, discussing the case in the New York *Electrical Engineer*, maintains, taking the Sibley College figures of magnetising currents necessary, that with the best new type of transformers, and grouping them, the manager of the above installation should be able to reduce his loss two thirds, and so sell 32,000 more secondary ampere-hours than at present without increasing the current output from the station, nor the cost for fuel. At Cornell University they have 1,300 lamps with 15 transformers with a maximum current of 35 amperes at 1,100 volts. They use two low-pressures, 52 and 104 volts, and Prof. Ryan adds, "considering the ease with which two transformers may be used for a three-wire sub-station, it is astonishing that this plan has not been more used for distributing from the larger sizes of transformers."

Electric Winding Machinery.—We are becoming quite besieged lately with electrical catalogues, certainly showing a healthy state of the industry. Messrs. Ernest Scott and Mountain, of Newcastle, whose list of dynamos we recently mentioned, have now issued a fine catalogue of "Electric Winding Machinery, Electric Motors, and Accessories," in connection with haulage, pumping, winding, and transmission of power generally, which is a speaking tribute to the extension of this important branch of electrical engineering. The "Tyne" dynamo, as specially constructed for mining work, has one huge two-pole magnet with a single coil on the top, and—shade of Swinburne!—two eyebolts. It is a very workmanlike machine, simple, exceedingly well-built and accessible, and moderate in price. For distances under half a mile to motors 300 volts is recommended as the best pressure, and over this up to, say, a mile 500 volts. Motors for cranes are specially illustrated, as well as smaller model motors. Electric pumping is dealt with fully, and the plant as supplied to the North Seaton Colliery is well illustrated. Diagrams are given of haulage plant, of which the company have had considerable experience. Hoists, cranes, and capstans electrically driven are shown, as already used in working; and for hot climates the punkah-puller will be acceptable. Electric coal-cutters, now beginning to prove very useful, are shown; and the list ends with "Tyne" combined engines and dynamos for light and power, telephones, cables, and lamps—altogether a very fine list.

Engineering Congress at Chicago.—The president of the World's Congress Auxiliary has appointed a committee to make arrangements for a conference on engineering education, as a part of the general engineering congresses to be held from July 31 to August 5. The scope of the conference will include all matters relating to the course of instruction and equipment of institutions giving instruction in civil, electrical, mechanical, mining, municipal, military, and naval engineering, and in architecture. Steps have already been taken to secure papers from leading engineers. The committee proposes, subject to amendment, the following list of subjects to be considered by the conference: 1. Present state of collegiate engineering education in the leading countries of the world, to include: (*a*) Historical outline as to origin, age, grade, and support of the schools and colleges giving engineering education; (*b*) qualification for admittance; (*c*) courses of study in civil, electrical, mechanical, mining, military, municipal, and naval engineering, and in architecture; (*d*) equipment; (*e*) laboratory work and field practice. 2. The ideal engineering education. 3. Maximum and minimum mathematics necessary for an engineer. 4. Modern foreign languages in an engineering course of study. 5. Practical laboratory work and field practice. 6. Shop, laboratory, and field equipment. 7. Original research by students. 8. Best method of training engineering students in technical literary work. 9. Best methods of studying current technical literature. 10. Drawing for engineering students. 11. Number of hours per day, days per week, and weeks per year required in college work. 12. Vacation work. 13. Graduation theses. 14. Degrees conferred. 15. Present favourable and unfavourable tendencies in engineering education. 16. Views of practising engineers as to the needs of engineering education. 17. Comparison between American and European methods in engineering education.

Electrical Subways.—Mr. Wm. Maver, jun., has an article on "New York's Electrical Subways" in the New York *Electrical Engineer* for the 4th inst. It seems that there are 70 miles of high-potential subways in the city, 45 miles of telegraph and telephone subways, and 160 miles of Edison conduits—in all, 275 miles. The material is mainly wrought-iron piping, but cast iron, cement, creosoted wood, etc., are also used. The ducts range from 2in. to 4in. in diameter, and there are in all 1,312 miles of ducts, exclusive of Edison conduits, of which there are 160 miles. Rough tests indicate that in iron piping self-induction losses are about three times greater when the conductors of each circuit are in separate ducts, than when they are in the same ducts. These pipes are 18ft. to 21ft. long and ¼in. thick, weighing 5½lb. to 8lb. per foot. They are dipped in asphaltum preservative mixture. Some of the obstructions found are of a curious nature. One was a mandril, another an old umbrella, cement and stones being naturally the most frequent. Plans are given of the running of the subways in different parts of the city, and a diagram is also given of a new form of distributing-box which has given much satisfaction. The subways have a capacity for 45,000 miles of telephone and telegraph conductors, and 5,000 miles of high-potential cables. There are at present 23,000 miles of telephone and telegraph wires laid, and about 600 miles of high-pressure cables, on 132 electric light and power circuits. Of these, 88 are continuous and 44 alternating. They carry current for, approximately, 3,300 arc lamps and 80,000 incandescents, and the circuits vary from one to 14 miles with a tendency to longer circuits, the maximum pressure being 3,500 volts; but the cables could probably stand up to 6,000 volts. The ducts are owned by six different electric light companies and six different telegraph and telephone companies.

Train-Lighting in France.—The French railway, the Chemin de Fer du Nord, will shortly, announces the *Bulletin International*, introduce electric lighting to the saloon cars, sleeping and toilet cars of the first, second, and third class on its lines. The company have decided, after long trials on isolated carriages, to experiment on a large scale. The current is obtained from accumulators supplying lamps of 6 cp., 8 cp., and 10 c.p., according to the carriages. The accumulators number 16, mounted in boxes in groups of two, being thus very portable. The eight double cells are arranged in boxes suspended beneath the frame: they are accessible from the steps and closed in by doors. Each cell is composed of nine plates—four positives and five negatives—contained in a small ebonite case, which is capable of carrying 11 plates. The plates are 200mm. high by 100mm. wide and 6mm. thick (7½in. by 3¾in. by ¼in.). The plates weigh 900 grammes each, or 8·1 kilos (17¾lb.) per cell, and they have a minimum capacity of 14 ampere-hours per kilogramme of plate (6½ ampere-hours per pound). Each cell complete weighs 12·73 kilos, and the two cells in a box weighs 30 kilos, and the whole 16 cells 240 kilos (or 528lb.), to which must be added 150 kilos (330lb.) for the carriers placed beneath the car. The battery has a total minimum capacity of 113·4 ampere-hours. Thirty-volt lamps are used of 10 c.p. for first-class cars, 8 c.p. for second-class, and 6 c.p. for third-class and lavatories of all classes. They consume 2·9 to 3 watts per candle-power, and have a minimum life of 300 hours. They are carried by a hard-wood cylinder carrying lamp, lamp socket, and reflector, the latter being of very white enamelled iron. This apparatus is slipped into the lantern, taking the place of the oil-lamp. Two switches are fixed in a little box at either end of the car, so that the lamps can be lighted or extinguished from the outside. The connections are arranged so that the batteries can be charged without taking them out of their compartments. The cables are made specially strong to stand the wear and tear. They are run along the roof fixed by soldered zinc clips. When the oil-lamps are required, all that is necessary is to open the lantern, take out the electric lamp with socket, and slip the oil-lamp into the same place.

Dynamo-Driving.—We gave an abstract on December 30th last year of a paper read by Mr. P. Diamond before the Engineering Association of New South Wales, on "Dynamo-Driving by Compound Engines." The following remarks on this paper and the discussion are given by the Australian *Engineering Journal*: "The author advances many points of interest, but they are so wrapped up and hidden as to be of little practical use. The readings of several diagrams appear to be in error, more particularly the one (No. 4) taken from the pair of compound non-condensing horizontal engines at the Centennial Hall, which are stated to give an efficiency of ·9. We are inclined to doubt whether any engines could be found yielding an efficiency such as this. Judging from the remarks made by various members, it is desirable to have the plant arranged in units of power, so that so soon as the load exceeds one power, another may be connected, thus saving the waste arising when the load varies between a minimum and maximum widely separated. Some of the leading electrical engineers of the Old World have been, and are, concentrating their energy and ability in endeavouring to do away with or materially reduce the friction of the motor used to develop electrical power. Mr. Diamond pointed out defects already well known to those conversant with this class of engineering, but failed to offer any suggestions as to how the difficulty might be overcome. A destructive policy is sometimes all that can be indulged in, but whenever possible a constructive one should be suggested in its place, because it is tolerably easy to point out defects that have long been recognised, but not so easy to offer some scheme which shall do away with such defects. Probably the members of the association will not be content to let the matter rest as it is, and when the new session commences someone will endeavour to take up the question where Mr. Diamond left off, to treat it more exhaustively, and endeavour, if possible, to show how the defects and loss of power may be obviated. Such a paper thoroughly worked up, would prove of lasting benefit, and at least show in what direction engineers must turn their attention if the desired end is to be gained. That Mr. Diamond has done good in bringing the subject forward no one will deny, but as the matter stands now it is incomplete, and unsatisfactory. This, however, does not restrain us from expressing the hope that it will not be so, and if an Australasian engineering association can at all advance towards the solution of this problem, which is proving itself a hard nut for the most expert engineers of the whole world, the author of the paper now under consideration will have achieved a worthy object."

Cobalt and Palladium Plating.—The paper by Mr. Swinburne last year on commercial electrolysis had the vast advantage of being intensely practical while ranging over a wide area. It may prove a veritable mine of wealth for some of the younger members of the electrical engineering profession, some of whom with a hint, the necessary knowledge, and a little *savoir-faire*, might carve out a serviceable slice of nutriment from that large oyster—the business world. There are many such hints given in the paper and the discussion, to which we may return again. But for the present moment we would direct further attention to the kindred processes of cobalt and palladium plating. Prof. Silvanus Thompson has drawn attention strongly, not only at the discussion, but at the exhibition at the Finsbury College, to the great advantages which arise from the use of cobalt instead of nickel for plating. "The one white metal," says Prof. Thompson, "which will stand a London atmosphere, with fog and the products of combustion, is the metal cobalt. I have in my laboratory articles coated with cobalt that retain their colour marvellously. Had they been coated with nickel, they would have been yellow in three months; or if with silver, they would have been black in a fortnight. Why do not nickelplaters use cobalt? It is as simple as nickelplating." Why not, indeed? Let us point out that the time is not so far distant since nickel was first used; that the introduction of nickelplating must have been owing largely to the enterprise and persistence of one man at first in bringing it before the market; that its use is now enormous and profitable; and that the same order of events will have to be followed in introducing cobalt. This field—and it is evidently a wide one—is open. Who will take it up and labour therein? Another process is that described by Mr. C. O. Lloyd in the "hard silver" plating—an alloy of silver with 10 per cent. of cadmium, which is now being taken up commercially on a considerable scale. But a third process—that of palladium plating—also mentioned by Mr. Lloyd, is not yet much used, though here also is a field for successful work. Says Mr. Lloyd, "the non-oxidisability of palladium and its perfect adhesion to the underlying metal—when these qualities become more widely known—point to a great future for palladium plating; and our experience with it shows it to be superior to any other metal for coating mirrors which have to stand the intense heat produced by arc lamps." The young electrical engineer stands in a similar position in the domains of physical science to that of the early settlers in the backwoods. The pioneers have prospected; it depends upon the endeavours and persistence of the early workers, and the proved utility of the process on which they work, whether a scientific discovery can be rendered serviceable and their own lives rendered comfortable by the returns from the practical application of their scientific knowledge.

Nottingham Technical Schools.—An extensive exhibition of electrical and other machinery has been arranged by Prof. W. Robinson in connection with the inauguration of the new technical schools of the Nottingham University College. Among the chief attractions is a working fast-speed Wheatstone telegraphic apparatus, lent by the Postmaster-General, which is connected from the research laboratory to the engineering-room, and messages are despatched from one to the other at the extraordinary high speed of 600 words per minute, a speed which has been specially obtained for the occasion. There is also a fine private collection of submarine cables and old telegraph instruments sent by Mr. G. H. Comport, superintending engineer of the North Midland district. Some beautiful specimens of cables are also sent from the Post Office by Mr. W. H. Preece, F.R.S. The electrical engineering arrangements are under the direction of Mr. G. N. Partridge, assistant superintending engineer, and the working of the apparatus by Messrs. E. W. Lloyd, Snowdin, Crane, Coke-Smith, Heany, Walker, and Wells, telegraphists who are students of the University College, under the supervision of the college teacher, Mr. F. G. Richardson. In the engineering laboratory is shown a very interesting mechanical device, by Mr. Joseph Goold, which consists of superimposed elliptical motions, similar curves being traced of varying amplitude by the application of friction, and beautiful effects and shading being produced. In the research laboratory there is an exhibit of electrical apparatus by Mr. R. W. Paul, of Hatton-garden, a former student of Prof. Robinson's. In the same apartment the National Telephone Company display many of the latest inventions in this direction, including a new call, which is caused by the vibration of two diaphragms; the stronger the current the higher the note. At the central tables in this room is a complete collection of accumulator plates, presented to the college by the Electrical Power Storage Company and the Crompton-Howell Company. Messrs. Crompton also exhibit on the ground floor a complete electric plant illustrative of central station apparatus, including armatures of dynamos, large accumulators, switches, and electric measuring instruments, as well as a model showing a culvert such as is used in the street, with the system for electric lighting. This is for low-pressure work, such as is intended for use in Nottingham. The Brush Company have sent parts of the Mordey alternating-current dynamos, with high-pressure transformers and switches. Messrs. Nalder, of London, show electric and measuring instruments, while in the same room is a cyclometer invented by Mr. Ransom, son of Dr. Ransom, and made by Messrs. Manlove, Alliott, and Co., for recording variation of speed in any part of the revolution of shafting. The main engine is another special exhibit, and was made by this firm, and drives the shafting of the ordinary machinery throughout the building. Prof. Clowes exhibits a lamp for detecting exceedingly small proportions of inflammable gas in the atmosphere, which is 22 times as sensitive as the ordinary safety lamps. There are, besides, many exhibits of the lace industry, and Prof. Robinson is to be congratulated on the success and interesting character of the exhibition.

WHAT IS ELECTRICITY ?—II.

BY SYDNEY F. WALKER.

In the present article, and in those with which he hopes to follow, the writer proposes to endeavour to support the position he took up in the former article on the subject.

It may at once be allowed that the subject is a very difficult one, and that it is principally so because so much of the work has to be thrown on the imagination. There is also another cause which makes an examination of the subject a difficult one—viz., that those who have given any thought to the matter, who have generally taken a different view from that put forward by the writer of this article, illustrate their arguments principally by references to laboratory apparatus, while engineers must necessarily look at the subject from the point of view of the practical apparatus they are in the habit of dealing with in their everyday work.

It was pointed out in the former article that one of the greatest difficulties that are met with in dealing with the subject is that of realising that every body is in motion within itself, not only when heated as we understand the term, but when it is in the state which we call cold.

Another difficulty, again, in lifting the screen that hides electrical actions from our view is that, as already pointed out, our senses do not give us any notice of electricity or even of electric currents *per se*, but only of the results produced by electricity, or by the passage of electric currents, after the force, or whatever we choose to call it, has ceased to be electricity.

We know that by making certain arrangements we create what we call an electrostatic charge, or we can cause certain phenomena that we have agreed to call the passage of an electric current, but we only know of the existence of the charge, or of the passage of the current, when either one or the other has been transformed into some other form of energy that our senses can take cognisance of.

Thus we know that by applying a certain E.M.F. to the terminals of a particular incandescent lamp, a certain current, as we have agreed to call it, will pass, and that when this current passes the lamp, if properly constructed, will be heated to a certain temperature, and will give out light equal to that given by a certain number of sperm candles. We are able even to accurately measure the quantity of coal and water that must be used in the boiler that is furnishing steam to the engine which is driving the dynamo to which the lamp is connected, in order that the lamp may give out its light for a certain time.

But with all this, far in advance as it is of what can be done in the sister branches of engineering, we only know of the electric current that has been, after it has passed, by reason of the heat which it has given birth to. And the same thing is true with an electrostatic charge. We see its effects when it has become heat in the form of a spark, whether it be from a Leyden jar or from a thundercloud; we can obtain mechanical evidence of its presence by means of an electroscope; but in neither case can we know that electricity is actually present in the same sense that we know that heat, or light, or sound are present.

Pausing a moment, seeing that we know of the presence of electricity only when it has become transformed into heat, in one set of phenomena, and seeing that we know that heat is a mode of motion, does it not seem probable that electricity is also a mode of motion, and that the conversion from one to the other is merely a variation of the period of the motion? Passing on to the position the writer has ventured to take up. This view is that heat, light, electricity, and sound are merely different forms of molecular motion, to which all substances are subject, but in different degrees. We know, for instance, that all bodies conduct all the forms of energy named, but with different facilities. Further, we know that, with a few exceptions, good conductors for one form of energy are good conductors for all the others, and bad conductors for one form are bad conductors for the others.

Further, we know that though the form of the motions we know as sound, light, and heat are different, they have this in common, that if free to do so their motions are transmitted radially in every direction from the body or substance that is under the influence of either form of energy at the time. We also know that with each of the forces mentioned we can confine the transmission of the motion which we know the force to consist of to any particular channel, by making this channel of a substance whose conductivity is very great indeed, compared with the conductivity of all other bodies near it. But this is exactly what we are able to do with electricity, and, as is well known, electricity will and does pass from a charged body, or from one at a higher E.M.F. to those at lower E.M.F. in all directions, in inverse proportion to the proportion of the resistances of the paths open to it, just as sound, light, and heat do.

The arrangements for transmitting sound by the acoustic telephone and by the electric telephone are identical, so far as the transmitting medium is concerned, with the exception of special arrangements, on the one hand, that are necessary in order that proper acoustic connection may be made at each end, and, on the other hand, of the necessity of a return path in the case of the electric current. The latter distinction the writer hopes to show in a later article is more apparent than real; that, in fact, return circuits exist with all physical phenomena, but that as the other forces have not lent themselves so readily to transmission, this matter of the return circuit has not received the attention it has in the case of electricity.

EARTHING THE RETURN.

BY J. D. F. ANDREWS.

Probably one of the greatest changes in advancement to be expected in the near future in connection with electrical distribution will be the introduction of an earth connection on all network systems with two or three mains.

The impossibility of maintaining the standard of insulation on electric street mains is a subject which is forcing itself on the minds of electrical engineers more and more as the networks of mains extend, and the installations become connected on, giving their addition to the earth leaks, and increasing the danger of fire in each individual installation, or especially in those of a faulty nature. With the existing attempt at a non-earth system the switches control the lights, but do not turn off the leaks. If, however, the suggestion to earth one of the mains were adopted (in accordance with the suggestion given in a letter from Mr. Human recently), the case would be different and greatly improved. According to this proposal, the switches and fuses would be inserted in the wire connected to the non-earthed main, and consequently whatever part of an installation were switched off is left at no difference of pressure with the earth and everything surrounding it.

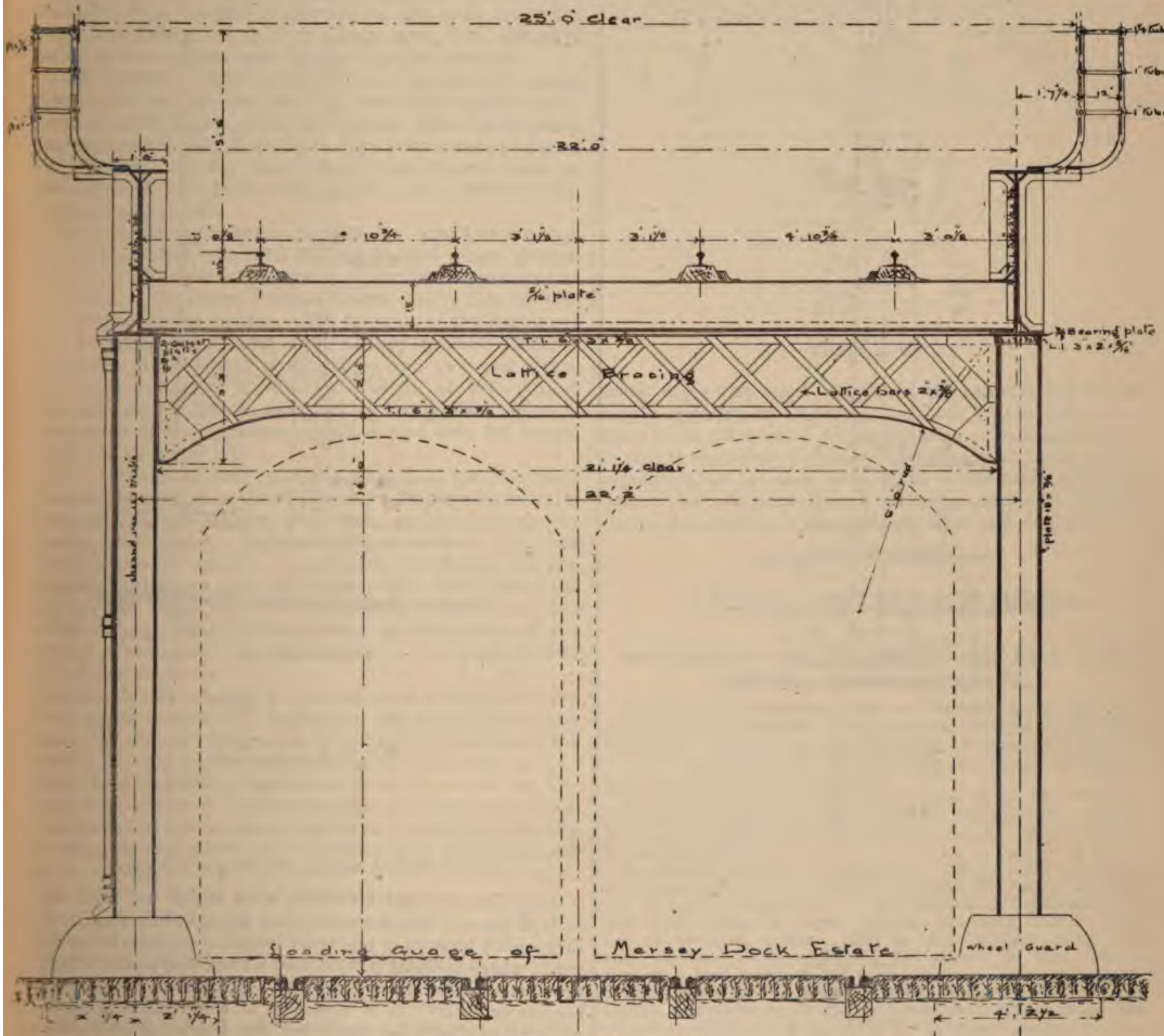
Leakages to earth are not altogether due to faulty installing, for however well the work may be carried out and good the insulation, there will inevitably be some leak, and it is only a matter of having sufficient of such leaks connected on it to collectively produce the extent of leakage that would be an open danger to any installation that might become defective in natural course of decay. This fact cannot be overlooked, nor can it be permanently improved by increasing the degree of insulation, but the suggested earthing of one of the mains obviously establishes a permanent condition of safety.

To produce the change above referred to does not appear to present much difficulty. The required position of the switches and fuses in one only of the wires is already the general practice, and it would not be a costly matter for the supply company to change over any installation in which the wire with the switches in is connected to the mains to be earthed.

Experience of earthing has been satisfactory in other countries, especially in connection with the three-wire system, and it has established the advantage claimed for it in its application to the two-main system in isolated installations by the writer in this country, and after the satisfactory tone of the recent correspondence in your contemporary, we may hope to see a more extensive adoption of the improvement in the early future.

THE LIVERPOOL OVERHEAD RAILWAY.

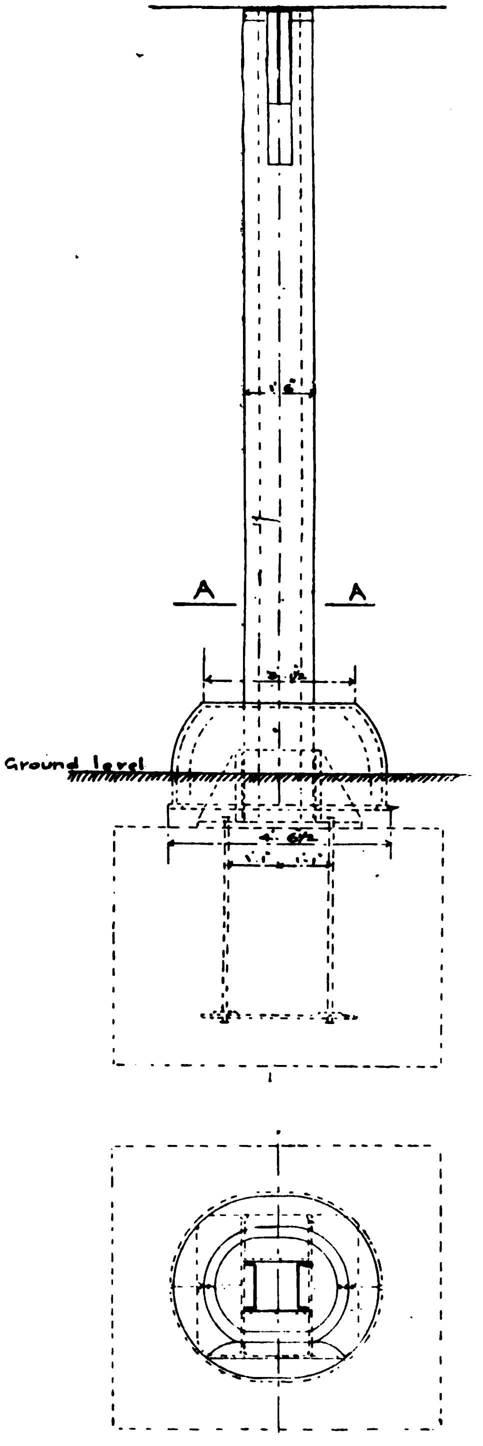
It is curious to note the extent to which engineers in this and other long-civilised countries have sought, as much as possible, to hide away in tunnels or cuttings the railroad lines that have now become essential to modern ideas of progress and locomotion—more especially in the neighbourhood of towns and cities. It is as though the average English mind had never reconciled itself to the loss of picturesque stage-coaches rattling along the country roads in a fashion that added to the attractiveness of landscapes, and could only endure the more speedy method of steam-locomotion so long as it was hidden away out of sight. The mere thought of allowing trains—whether loaded with goods or passengers—to openly traverse public streets and highways (as may be seen in hundreds of towns throughout the United States) would create such a storm of indignation in this country, that in all likelihood the line would soon be torn up and the rolling-stock converted into raw material for the scrap heap and wood pile. The same feeling would, to a less extent, without doubt be aroused by a proposal to build along any leading thoroughfare in a city such a system of overhead railway line as the Manhattan Elevated, of New York—more familiarly known as the "El.," or "L" simply; and no inconsiderable credit is therefore due to the energetic promoters of the Liverpool Overhead Railway—the first of its kind to be erected in this country, though it is to be hoped by no means the last—for successfully carrying through to its final stages a project that offers points of extremely great interest to every engineer, whether civil, mechanical, or electrical. It may be said with some amount of truth, perhaps, that the new line has been favoured by local conditions, but this very fact reflects credit upon those who were responsible for choosing this place and route for the first completed instance in this country of a railroad system which has many undoubted advantages from every point of view, whilst the chief objections to be urged against it are perhaps merely of a sentimental nature. True, a line of this kind should prove invaluable along the docks or shore front of a port, where passenger traffic of a business nature is incessant, and goods waggons more in evidence than broughams; and for this reason alone the new line ought to make more friends than enemies. That it is of an obtrusive and objectionable character in itself can hardly be granted by anyone who has inspected the line. The illustrations appended to this article show to some extent its modesty in appearance. The line is, however, eminently utilitarian, and nowadays that is sufficient for most of us.



Liverpool Overhead Railway.

In chronicling its successful completion—the formal opening of the line by the Marquis of Salisbury is announced to take place on the 6th of next month—it is advisable, perhaps, first to give some few details of the origin and inception of the undertaking.

For many years past both the goods and passenger traffic along the side of the Liverpool docks has been served by a double line of ordinary rails, laid down to standard gauge on the road surface, and with the sleepers covered in with paving somewhat after the fashion of a street tramway. By means of horse traction, the goods waggons from any of the main lines running into Liverpool and connecting with the dock railway, have been drawn from the termini to any desired point along the line, whilst the passenger service has been maintained by cumbrous omnibuses, with wheels specially designed to run on the rails, whilst allowing the vehicles to be turned off upon the paving whenever the line might happen to be occupied with the goods traffic.

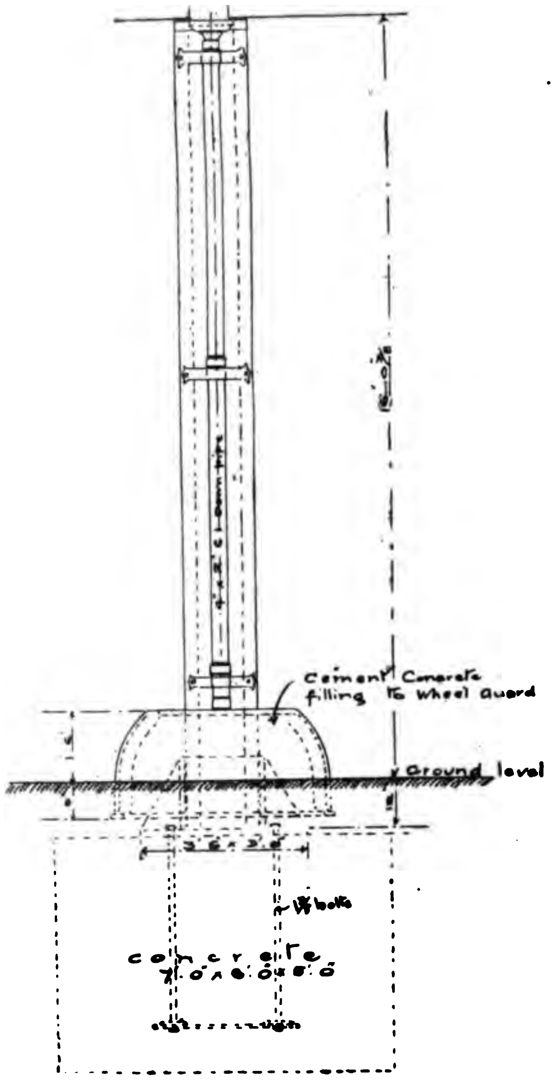


SECTIONAL PLAN AT AA

Liverpool Overhead Railway.

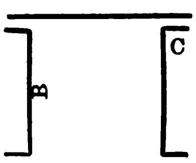
It has been the aim of the projectors of the new line to replace the latter service by a much more efficient, rapid, and comfortable method of conveying passengers from one point of the docks to another, whilst at the same time leaving the line already existing to be employed solely for the constantly growing freight traffic.

The new line throughout its present entire length of six miles is built directly over the old dock railway, but at the ends—north and south—it is proposed to make extensions inwards, so as to reach some of the more populous suburbs of Liverpool, and thus serve as a convenient means of reaching the docks and centre of the city from any quarter.



Liverpool Overhead Railway.—Side Elevation of Column.

Since the overhead structure, upon which are laid the rails of the new line, is erected upon wrought-iron standards throughout (excepting one short length of perhaps 50 or 60 yards, where the road is solid, and a few other places where the line crosses streets, etc., and girders of large span become necessary), it is a matter of comparative ease to avoid all gradients by regulating the height of the standards. There is, in point of fact, only one "dip" where the line passes under the Lancashire and Yorkshire Railway, and thereby ceases to be for that short distance an "overhead" line. The vertical supporting columns are placed opposite one another on each side of the line, and are formed of channel-iron or troughing placed back-to-back and riveted together by iron plates, the horizontal section being somewhat as follows :



A = 1ft. 6in. wide (thickness, ⅜in.); B = 12in. wide (thickness, $\frac{7}{16}$in.); C = 3½in. deep (thickness, $\frac{7}{16}$in.).

These are each secured at the base by means of heavy cast-iron angle plates and bolts, to four long foundation bolts, $1\frac{3}{8}$in. in diameter and 4ft. 3in. long. The latter are embedded in a mass of concrete formed round them, measuring 7ft. in width, 6ft. in length, and 5ft. deep. A heavy casting—oval-shaped at the base—is also bolted to the base of each column in two halves, to act as a wheel-guard or fender, protecting the columns against the wheels of drays or other vehicles. This guard rises above the surface of the ground to a height of about 18in., its total height being 2ft. 3in. The space inside each guard—between its inner shell and the column—is filled in with concrete cement up to the top of the guard. Upon these standards or columns rests the superstructure, which is formed practically of plate girders, in spans, each of which stretches from one pair of columns to the next, somewhat after the fashion of a four-legged table, and therefore being of the simplest and cheapest type to construct.

The distance between the columns from centre to centre across the line is 22ft. 2in., the clear width inside—available for traffic below—being a little over 21ft. The majority of the spans in length are 50ft. $1\frac{3}{8}$in. from centre to centre of columns, and the clear height from ground level to underside of plate girders forming the base of the structure, averages about 16ft.

The tops of the columns support—by means of bearing-plates $\frac{3}{8}$in. thick—the ends of longitudinal plate girders, built up in the ordinary spans of 11 sections or panels. At the joints of the latter, T-iron stiffeners, 5in. by $2\frac{1}{2}$in. by $\frac{3}{8}$in., are riveted on the outside. The majority of the panels are 5ft. in length, there being eight of these in each girder—one panel 8ft. in length at the centre, and two end plates, 1ft. $3\frac{5}{16}$in.—making up the total length of 50ft. $\frac{3}{8}$in., so that $\frac{1}{2}$in. play is left at each end of the girder. Most of the panels have a thickness of $\frac{3}{8}$in. in the web, the height of the latter being 4ft.

On the top of each girder is riveted a $\frac{3}{8}$in. iron plate 16in. wide secured to the stiffeners on the outside, and also to similar T-iron stiffeners, $5\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{3}{4}$in., on the inside of the girder. The latter are, however, of 15in. less depth than the former, in order to allow room for the arched floor-plates running transversely from girder to girder, and supporting the longitudinal timbers and line rails without ballast of any kind. A description of the arched flooring and its attachments to the plate girders will follow later on.

Between the columns a light tranverse bracing of lattice bars serves to materially strengthen the sub-structure, and make the columns better able to resist the spreading action due to moving train weights overhead. This bracing consists of a frame 2ft. deep, made up of T-iron 6in. by 3in. by $\frac{3}{8}$in., and lattice bars 2in. by $\frac{3}{8}$in., and is secured to the columns at each end—where the depth is increased gradually to 3ft. 3in.—by means of two gusset-plates $\frac{5}{16}$in. thick, and angle irons.

(To be continued.)

CLAMOND'S MICROPHONE.

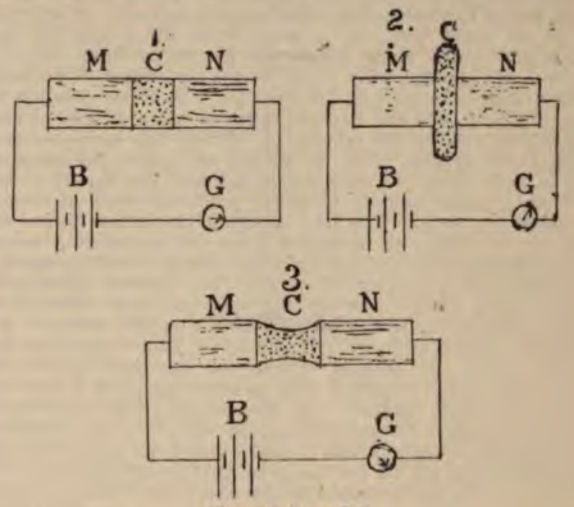
BY E. ULDALL.

This new invention is based on a principle quite the reverse of that generally used in the construction of microphones. Instead of effecting the variation of resistance in the circuit by the loose contact between elastic but undeformable conductors—as carbon—he employs a medium which is plastic and deformable.

M. Clamond makes a plastic paste by mixing very finely-divided conducting powder with viscous liquid—a more or less bad conductor for the current; it is this product which he substitutes in the microphone for the carbon.

The figures show the principle for the functions of this instrument thus constituted. A battery, B, and a galvanometer, G, are joined up with two metal electrodes, M and N, connected by the cylinder, C, formed of the paste, which sticks to the electrodes, Fig. 1. This plastic cylinder alters its section and its resistance, as the poles are moved to and from each other. Are the poles neared? then the length of the cylinder is shortened, its section gets greater, and, consequently, its resistance is diminished, Fig. 2; if the poles move away from each other, then the cylinder gets longer, its section smaller, and its resistance increases, Fig. 3. All these movements influence the reading on the galvanometer.

Now, suppose the pole, M, to be fastened to the vibrating diaphragm of the microphone while M is immovable. The sound-waves will then successively alter the section—*i.e.*, the resistance of the cylinder; and if a telephone receiver is put in the circuit it will repeat all the sounds produced before the microphone. As the vibrations of the diaphragm have only a very small amplitude, the accurate dimensions of the cylinder, in proportion to those of the electrodes, have to be determined by experiments. This microphone is able to reproduce the most different sounds without any regulation, as by other instruments of the same kind, and even if the talk varies from a low whispering to the loudest shout, the audition is always loud, clear, and distinct.



FIGS. 1, 2, and 3.

LEGAL INTELLIGENCE.

HOPKINSON v. THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHTING COMPANY.

In this case on Saturday last, Mr. Justice Romer delivered judgment for the plaintiff. The action was brought by Dr. John Hopkinson to restrain an infringement of his patent for improvements in the distribution of electricity by means of what is known as the "three-wire system."

Mr. Aston, Q.C., Sir Richard Webster, Q.C., Mr. Moulton, Q.C., and Mr. Hopkinson, Q.C., were for the plaintiff; and Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. Roger Wallace for the defendants.

Mr. Justice Romer gave judgment as follows: The only point for decision in this case is whether the plaintiff's patent is valid, for, if valid, infringement is not denied. The decision on this point depends upon certain questions not of law, but of electrical science, and, in my opinion, more suitable for the consideration of an expert in that science than of a legal tribunal. I have, however, been assisted by the evidence of skilled witnesses of the greatest distinction, and though, unfortunately, as generally happens in patent cases, the experts on the two sides do not agree, I have been enabled to come to a conclusion with regard to the objections taken to the patent, and that conclusion is that the objections fail, and that the patent is valid. In dealing with these objections, I will first consider those taken to the second claim in the patent, being the claim which relates to the invention now known as the "three-wire system," and is the invention used by the defendants, and in respect of which relief is sought in this action. On this part of the case it is of the utmost importance to understand what, according to the true construction of the specification, is the invention claimed by the patentee; and to understand the specification, which is a document of necessity addressed to and framed for the consideration of the small circle of persons acquainted with the difficult subject to which it refers, the following facts should be borne in mind. At the date of the patent there were two known systems of distributing electricity for the purpose of electric lighting to which the patent was practically directed. I am aware that, theoretically and in its terms, the patent was not confined to the purposes of lighting, but extended to any purpose requiring the consumption of electricity in a system where the electricity is supplied at a fixed potential; but I am satisfied that this extension is of no practical importance for the purposes of my judgment when it is remembered that consumers of electricity generally (such as motors) can only be used with the plaintiff's invention when the electricity is supplied at a fixed potential; and I shall, accordingly, hereafter only refer specifically to lighting, though it must be understood that I intend in my subsequent observations to include the more extended purpose of the patent, and where relevant and proper the necessary extensions of phrase to cover such extended purpose must be taken as intended, though for the sake of brevity and clearness I may speak only of electric lighting. The two systems I have referred to are in the evidence before me, and may properly be spoken of shortly as the "parallel" and the "series" systems. These two systems differ in principle. In the parallel system of lighting, which chiefly concerns incandescent lamps (though arc lamps may be used but with difficulty and not so usefully), the supply of electricity is at a fixed potential, with varying current. The system derives its name from the parallel wires which tap the main service conductor, along which the electricity flows from the dynamos and join the other main service conductor, down which the electricity flows back to the dynamos. On these parallels the lamps are hung, and the current varies as more or less of these parallels are used for the purpose of lighting the lamps on them. In the series system, used chiefly for arc lights, the lamps are hung in series along the main conductor and the supply of electricity is at a fixed current, while the potential varies as more or less lamps are burnt. The first question that arises in the case before me is whether the invention I am now considering was by the specification intended and shown to extend to both systems, or to be restricted to the parallel system. For reasons which I will hereafter give, when examining the specification in detail, I am satisfied that the claim was confined to the parallel system. And I may now shortly state what the invention was. Before the date of the patent the parallel system was not only well known but had been much improved from its first stage, which has been called the "simple parallel." In the simple parallel there was no connection between the parallels except by the main conductors, and the consequence was that if one lighted lamp on any parallel had to be turned off all the lamps on that parallel had also to be turned off. The improvement on this was called "the compound or multiple parallel," and consisted in placing a wire which joined the middle points of the parallels, so that on each parallel there occurred a lamp or lamps on each side of this intermediate wire. By this arrangement the lamp or lamps on one side of any parallel might be turned off and yet leave the lamp or lamps on the other side of that parallel still burning. But even this compound parallel system had a great defect, arising from the fact that the turning off of lamps from one side only of the middle wire had the effect of increasing the brightness of the lamps remaining burning on that side and diminishing the brightness of the lamps burning on the other side. So that, in practice in a system of electric lighting, lamps kept varying in brightness from time to time as other lamps on the system were turned off or on, and this fluctuation of the lamps was a considerable drawback to the use of the system, especially in private houses. The patentee discovered the means of remedying this by a contrivance as simple as it was useful. He joined the intermediate wire to the wire connecting the two dynamos working in series, and the thing was done. For it was found (speaking shortly, and not with scientific accuracy) that the difference between the electricity used on the two sides of the middle wire, which caused the difference of brightness under the old compound parallel system, passed away down the central wire to the dynamos under the inventor's system, and ceased to act as a disturbing element in the intensity of the burning lamps, and thus the brightness of the two sides was kept equalised and steady. The system so perfected, and which, as I have said, is now generally spoken of as "the three-wire system," was of great practical utility, and in lighting on a large scale permitted the main copper conductors to be comparatively small, without risk of bursting lamps—thus effecting a considerable saving in copper (which was for practical work a great desideratum) and also a saving in the expenditure of electrical energy. The advantages of the discovery, of course, increased as more parallels and lamps were used, and were of considerable practical importance only in the case where several lamps and parallels were used, and became minimised when only two parallels were worked. I will now examine the specification in detail, in order to see that the contention on the part of the plaintiff is established—that the claim in the patent is confined to the parallel system. Now, it is true that throughout the patentee does not use the term parallel to define the system he is dealing with. I believe this to be because he preferred to use the appropriate scientific terms to describe the system rather than the popular terms. But, in my opinion, when the specification is read with care and fairness, and well understood, it is clear that the patentee is thereby confining his claim to the parallel system. He shows throughout that he is dealing only with a system in which the potential is to be kept constant at the places where the electricity is to be supplied, and in which the current varies as more electricity is required to be used on the different wires that tap the main conductor—that is to say, that he is dealing only with the parallel system, for, on the balance of evidence, it is clear that the characteristics I have named denote the parallel system, and only that system. At the commencement of the specification (page 3 of the print, lines 7 to 10), where he refers in general terms to his invention, he shows that the system he is dealing with is one where the E.M.F. is supplied at a fixed potential. Now, that as a phrase is well known to electricians (see *inter alia*, evidence of defendants' witness, Mr. Swinburne). Moreover, I think that the words "such conductors," at line 9, mean "conductors for an electric supply at a fixed potential" It is possible, however, that the words may mean merely "conductors for an electric supply," and I therefore pass on, only observing that the sentences immediately following (and in particular the phrases on lines 12 to 17 and 24 to 25) appear to me to support the view I have taken as to the meaning of the words "such conductors," in line 9. Then, at lines 9 and 10 and 31 to 38, the patentee describes what his invention is and its special advantages, substantially as previously pointed out by me in this judgment. At lines 9 and 31 he shows that one of the advantages is economising the cost of the main conductors, and I may add that the very expression "main conductors" implies branch conductors, which do not really exist except on the parallel system. At lines 9 to 10 he shows that this can be done "consistently with efficiency and safety"—that is, as I understand it, with efficiency, so as not to disturb the brilliancy of the lights, and with safety, because, on this system, there was no risk of bursting the lamps by over-pressure on any particular lamp. Then, at lines 35 to 38, he shows that the object and effect of his third wire is to bring back to the dynamos the excess of electricity required for the lamps on the one side of the central wire over that required for the lamps on the other side. I may now pass on to page 5, line 32, where the patentee proceeds to describe in detail the particular invention I am now considering, merely remarking, in passing, the observations at page 4, lines 44 to 53, as clearly referring to the parallel system. Now, the detailed description at page 5, lines 32 to 48, when fairly read, in my opinion, shows clearly that the patentee was referring to the parallel system only, many of the expressions used, as well as figure 5, being inapplicable to the series system. Then, when I come to the second claim, at page 7, lines 7 to 21, being his claim in respect of the invention I am now considering, I find it clearly made with reference to his detailed description at page 5, lines 32 to 48, and to figure 5, which, as I have before said, in my opinion, refer to the parallel system only. Moreover, in a question of this kind, depending as it does on what meaning electricians would attach to the technical phrases used in and the wording of the specification, I am entitled to take into consideration the views of the experts called as witnesses before me. With regard to this, I need only say that, in my judgment, on the balance of the evidence, which is to some extent conflicting, it establishes that the specification, to an electrician, would show that the parallel only is the one referred to by the patentee. But, indeed, on this point there is not so much difference as might be expected, as the defendants' experts generally admit that the patentee was thinking of the parallel system, though they are not agreed with the plaintiff's experts that he has with sufficient clearness, in his specification, confined his claim to that system. And some of the statements made by the defendants' experts are very significant as supporting the plaintiff's case—as, for instance, Mr. Swinburne's evidence on the seventh day. Having come to the above conclusion as to the meaning of the specification, I now proceed to consider the objections to the claim. The utility of the invention cannot be disputed, but it is said, for the defendants—first, that the invention has been anticipated; and, failing this, secondly, that, having regard to the state of knowledge at the date of the patent, there was no sufficient merit, discovery, or novelty in the invention to sustain or form the proper subject of a patent. As to the first objection, there are in substance three alleged anticipations relied on by the defendants—namely, those which may be shortly referred to as the Sauchie Hall, the Alexandra Palace, and the Inchigore installations. A few others were referred to in the evidence, such as the installation on the steamship "City of Berlin," but these did not substantially differ from the Alexandra Palace and Inchigore cases, and need not be separately considered by me. Now, if the defendants' case as to Sauchie Hall had not broken down, an anticipation would have been established. But on the whole evidence as to this I am satisfied there was no anticipation, and that the installation at Sauchie Hall was not the plaintiff's three-wire system at all, but at most merely a case of the ordinary multiple parallel, where the middle wire is not connected with the dynamos. There were two witnesses for the defendants (Andrews and Town) whose testimony, if it could have been accepted, would have established that the third wire was connected with the dynamos. Sir Horace Davey in his summing up referred also to witness M'Killop, but in justice to that witness I am bound to say that, taking his evidence as a whole, he did not purport to say from his own knowledge that the third wire was connected with the dynamos. Now as to Andrews and Town I am sorry to be obliged to say that I cannot give credit to their testimony on the point. This Sauchie Hall case broke down, and may be dismissed from further consideration. Then as to the Alexandra Palace case, that was, in my opinion, no anticipation. The following are the conclusions I come to from evidence before me, taken as a whole: This Alexandra Palace installation was not a case of the parallel system at all. It was really a mere case of two arc lamps in series with a common return between them to the dynamo. When both lamps were burning they were burnt in series on one main conductor, and the whole electric current went along the main conductor through the two lamps, and for all practical purposes no electricity passed down the return or central wire. When one lamp only was burnt, the central wire—which was as thick as the main conductor—operated as part of the main conductor, and the electric current went along this one conductor only through the lamp back to the dynamos. There was no tapping, and certainly there were no parallels. There was no saving of copper in the way and of the kind effected by the plaintiff's invention. The third wire was, as I have already said, in fact, of the same thickness of copper as the main conductor, and such saving of copper as was effected was only such as is always obtained when a common return is used—that is to say, that instead of having four main conductors to burn two arc lamps separately, you have three only because of the common return. The central wire cannot be said fairly to carry away excess of electricity between lamps on one side and lamps on the other within the meaning and spirit of the plaintiff's invention and specification. For all substantial purposes the central wire either took back the whole current or none. The practical advantages of the plaintiff's invention were not, or were certainly not all, obtained in this installation. And I think it is not a fair objection to the novelty of a process which is intended to be, and which is of great use when applied to a system comprising many things, to say that the case of one has not been expressly excluded by the inventor, and that as the application of the process to the case of the one, so far as it could be applied to the one, was known, therefore the process has been anticipated, though the utility of the invention practically disappears when the case of the one is considered. If such an objection were allowed, there could never be a valid patent for many important discoveries—as, for instance, for many discoveries in connection with multiple telegraphy. Then as to the Inchigore case. That, in principle, is not distinguishable from, and does not go beyond, the Alexandra Palace case. The only difference is that instead of one lamp on each side of the central wire there were several lamps. But the lamps were in series—the same number on each side—and, as before, either all the lamps were burnt in series on a main conductor, in which case substantially no current passed down the central wire, or one set of lamps was burnt in series, in which case the central wire became part of the main conductor, and substantially all the current flowed down it. In this case, as in the Alexandra Palace case, one of the essentials of the plaintiff's system was absent—namely, the joining of the middle points of the bridges or parallels to one another. All the remarks I have made with regard to the Alexandra Palace case, in fact, apply to this, and I need not repeat them. It follows that the alleged anticipations fail. Then as to the second point—that there was no real invention made by the patentee—the case is put most strongly for the defendants in the following way: It is said that, taking the Inchigore case, you could easily turn the series lighting into parallel, and that to do this required no invention, and that if this were done you had the plaintiff's invention. It is also said that, taking the known compound-parallel system, it required no invention merely to connect the third wire with the dynamo, especially as this had been done in the common return and in the Alexandra Palace and Inchigore cases. But I think these views fallacious. No doubt, now that the thing is done, it is very easy to understand, and becomes obvious to all. But I do not think that it was obvious until discovered, or that it could be arrived at without thought and experiment. An electrician who knew all that had been done up to the date of this patent, and who set himself down to try and cure the known defects of the existing compound-parallel system, would by no means as of course have hit upon the plaintiff's invention. In particular I think that it would probably never have occurred to him to regard the Alexandra Palace and Inchigore installations, which were series systems, as being likely to lead to a solution of the problem, or to try the effect of turning the Inchigore series lamps into lamps on parallel. Certainly, in my opinion, he could not have come to the conclusion that such an attempt would result in success without investigation and experiment, especially when it is borne in mind that the Alexandra Palace and Inchigore lamps would not have burnt in parallel. And a convincing proof that the plaintiff's discovery was not obvious lies in the fact that there were skilled electricians who at this time knew of the series and parallel systems, and some of them had about this time to put up installations on the parallel system, in which it would have been a great advantage to use the plaintiff's invention, and yet it never occurred to any of these electricians to use it, and the invention remained undiscovered by them. Take, for example, the case of the defendants' witness Mr. Crompton, who put up the Alexandra Palace installation, and of Mr. Siemens, who put up the Inchigore installation. The fact is that electricians, knowing the compound-parallel system, and having the Alexandra Palace and Inchigore installations before them, were on the verge of making the plaintiff's discovery, and yet though they were all eagerly searching for novelties and improvement, they never made it. And it is a significant fact that Prof. Silvanus Thompson (one of the defendants' witnesses), for the purposes of a lecture, about this time prepared a diagram showing all the principal and newest systems or methods of lighting which were known or occurred to him, and yet it never occurred to him to suggest a system like the plaintiff's. For these reasons I think the second objection fails, and I have thus dealt with the principal objections to the patent. But there are one or two minor points taken on behalf of the defendants with which I must now shortly deal. It is said that the plaintiff's specification is insufficient, inasmuch as the patentee says his system is applicable to the case of alternate currents, and the defendants allege that to work dynamos in series, in alternating currents, they must be rigidly coupled and that a workman is not told by the specification to rigidly couple the dynamos, and would not know that he ought to do so. Now, on this point there is considerable conflict of evidence, but on the whole I am satisfied that the objection is not substantiated. I think that any workman of ordinary skill who would be employed to put up the dynamos to be used according to the plaintiff's specification, would know that the dynamos to be worked in series with alternating currents must keep time, and that the ordinary method of effecting this would be rigidly coupling the dynamos. The fact is that for many years prior to the patent the dynamos had been rigidly coupled in practice, and at the date of the patent it was a somewhat novel discovery that, as an exception to the general rule, rigid coupling might be dispensed with when the dynamos were not in series. I need only add that a portion of Lord Kelvin's evidence on this point, relied upon by defendants' counsel, has, I think, been misunderstood. I think Lord Kelvin was there considering the case of an ordinary workman with no experience or knowledge as to dynamos. I do not think he meant to suggest that a workman of ordinary skill—such a man as would naturally be employed in putting up dynamos—would have experienced any doubt or difficulty in putting up the dynamos so as to make them work efficiently in series with alternating currents. But, if he did, then I think on the balance of evidence as a whole, that he was mistaken in this part of his testimony. The above substantially exhausts all the objections taken to the plaintiff's invention that is the subject of this action. But the defendants say that plaintiff's first claim—which concerns what I may call the potential-measuring machine—is bad, and so the plaintiff's patent must altogether fail even though the second claim, by itself, would be good. But the defendants have failed to satisfy me that the first claim is bad. In the first place, they say the invention claimed is not useful. On the balance of the evidence before me I am satisfied it is a useful invention, and can be used to advantage, though, owing to a variety of circumstances, it may not have been used commercially in its simple form, as described in the patent, up to the present time. The defendants' only other objection to this first claim is based on the allegation that the machine will not work as a practical machine with alternating currents, owing to locally-induced currents thereby caused. On the balance of the evidence before me I am satisfied that it will work. I think, moreover, the specimen of this machine made for the plaintiff was fairly made according to the specification, and that specimen certainly worked well. No doubt, if you are perversely ingenious enough to sit down and see how you can make a machine which, though nominally in accordance with the plaintiff's invention, yet will not work, you may succeed. The model produced by defendants shows this; but that model I do not regard as fairly made in accordance with the plaintiff's invention and specification. Having now dealt with all the objections against the plaintiff's patent urged before me, and shown that in my judgment they fail, I grant to the plaintiff the usual relief sought by him against the defendants as infringers, with costs.

His Lordship gave the plaintiff costs on the higher scale, but suspended the injunction for six months.

LONDON INSTITUTION.

Dr. Silvanus Thompson gave the second of his three lectures on electric lighting before the London Institution last night, the subject being "Lamps." It was, he said, in 1819 that a report was made on the use of gas, then just invented. The gas, said the report, was of a disagreeable yellow colour as compared with the warm glow of candles; it was of dazzling brilliancy; the distribution was irregular and difficult, and even though engineers might overcome this, the cost would always be far greater than candles. We have heard the same thing said of electric light. The lecturer went on to explain the invention and development of arc and incandescent lamps, from the time of the discovery of the arc light by Sir Humphrey Davy in 1802. From this date to 1845 there was a gap, when about this time there were several attempts to have mechanism to regulate the carbon—Staite in England, and Foucault in France. Jablochkoff's lamp was the first to work without mechanism, and the exhibition in the Avenue de l'Opéra, in Paris, started the electric boom. Inventions relating to electricity were taken up with avidity, and people were all waiting for "subdivision of the electric light" Lord Justice Grove had already lit up the London Institution itself in 1847 with white-hot spirals of platinum wire, and no sooner was the boom of 1877 and 78 started than attention was turned to the early efforts. The story runs that an American financier entered the Western Union Office where Edison was sitting, and flourished a 100,000 dollar bill in his face, promising him it if he could "subdivide the electric light." Edison accepted, and a few weeks after informed his friends he had succeeded. His friends, through the cables, informed Europe, and gas shares dropped in a month from 200 to 140. The lamp that caused this scare was a platinum spiral, with a by-pass thrown in when the air expanded—little else but Grove's spiral. This would not work, so Edison tried spirals of platinum on a lime cylinder. At this time Lane-Fox made in the *Times* the absolutely first announcement that it was sufficient to make the lamps of high resistance to subdivide the light. Tyndall spoke of the idea as an important advance, and Edison jumped at it and put it into his specification. Now came another advance. Mr. J. W. Swan showed in public in February, 1879, the first lamp using carbon instead of platinum. The news of this was cabled across, and Edison, who had strongly condemned carbon entirely before, put this also in his specification. From that date Edison used carbon; but, of course, it would not do to use an old thing without acknowledgement, so a new *name* was invented—Edison called it a "filament." Swan's is a carbon rod and Edison's a filament! Edison spent a great deal of ingenuity in bringing his lamp to perfection, using bamboo to produce his carbon, the cane being carbonised in a way which Edison developed with consummate skill. Meanwhile, Swan showed how to produce carbon wire from ordinary cotton thread treated chemically, and since then we have the ordinary incandescent lamp much in its present form. Calculations show that when the cost of lamp renewals amounts to 17 per cent. of the total cost of carrying on the installation, including interest of the plant, the most economical point is obtained. The lecture next Thursday, at 6, will be on "Distribution."

THE

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BOUND VOLUMES.

Vol. IX. of new series of "The Electrical Engineer" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

FOR INVESTMENT.

Some years ago, if our files are consulted, it will be found that we advised the purchase of Brush shares at the price they then stood as a good, safe investment. Following that advice, time has proved, meant the making of a good lump sum of money. We will again put on the mantle of prophecy, and advise investors to buy—buy largely—buy all they can, of "London Electric," if they can buy at anything under *one*. Perhaps in this case it will be wise to give reasons, so that anyone may think the matter out for themselves and not buy blindfold. The annual balance-sheet is due in March, therefore our forecast is somewhat premature, as at the present moment we doubt if absolute figures are anywhere obtainable. Still, according to the balance-sheet given in our issue of March 25, 1892, the capital account stood at £797,680—call it in round numbers £800,000. There was a loss on the working according to that balance-sheet, and we fancy the forthcoming balance-sheet will also show a loss. Venturing, however, to analyse figures we have not seen, a close examination of them will probably show that on the working of the station the income is not far from balancing the expenditure, but in addition to the ordinary expenditure it will most likely be found there is some extraordinary expenditure—really, capital expenditure, which may, however, be charged to revenue. But of this we know not. We believe, however, that condensers and additional steam and dynamo plant has during the year been added. So far so good. Presuming that the revenue is gradually creeping up, with expenditure kept at the lowest limit, and working in the future as smoothly as the station has been working during the past year, we may—nay, we must—take it that ere long revenue will overlap expenditure. The capital is nominally £800,000, in £5 shares. The real value to an investor who could buy the whole of the shares at £¾ would be £120,000; if at £1, would be £160,000. The increase of revenue to a point which would give a profit of £8,000—and this ought to come within the next two years—means a dividend of one per cent. on the nominal capital, or *five* per cent. upon the capital invested at the rate of £1 per share. But the shares can now be bought less than £1, so the return under these conditions would be more than five per cent. We cannot hold out any very great hopes that in this year of grace 1893 a sufficient volume of business will be transacted to earn a profit of £8,000, or any profit, but we do expect that the working will, at any rate, show no loss. If the existing holders believe this the quotations will harden up, for many of the shareholders can well hold their scrip. Whatever be our readers' opinions on the subject, it would be just as well that they kept an eye upon the London Electric. When the balance-sheet is issued they should carefully examine it, although they will then have less opportunity, if our views are correct, of getting in at the lowest price. It is a very different question for investors who come in now, to that which exercises those who have been shareholders from the commencement. A small percentage upon the nominal capital means a large percentage upon the capital invested now by purchase. The more this position of matters is investigated at the present moment, and with present quotations, the more favourable, we believe, investors will find it.

THE THREE-WIRE SYSTEM.

The long-expected decision of Mr. Justice Romer in the case Hopkinson *v.* The St. James's and Pall Mall Company, in which the validity of the patent relating to the three-wire system of distribution was disputed, was delivered on Saturday last, and will be found in other columns. The patent has been upheld. The owners of the patent—the Westinghouse Company—write to say they "agreed to a suspension of six months of the injunction, out of regard to the great public inconvenience that would have been caused by a summary stop being put on the electric lighting of the St. James's district." It is, we think, unfortunate that the Westinghouse Company has thought fit to publish this information, for we have it upon the best authority that the St. James's Company could without inconvenience stop using the system at any moment, and it calls particular attention to the fact that the system is under the control of a foreign company. There is no reason why the Westinghouse Company should not reap due reward for its long-sightedness, and the English companies pay for their laxity in this respect; but none of us like it, nevertheless. So much for the letter. As regards the validity of the patent, it was hardly thought that this would be disputed after the breakdown of a certain part of the evidence, which at the first glimpse went far to prove prior and public usage. The infringement was not denied—the validity of the patent was denied. That several men were, just at the time the patent was obtained, sailing close to the discovery is certain, but it seems equally certain that no one, till Dr. Hopkinson told them to do it, put two dynamos in series and used a common return to what we may call their central terminals.

THE HOWARD LECTURES.

When the history of societies comes to be written it will be found that probably the Society of Arts has played a more prominent part than any other in the technical education of the nation. The Cantor lectures have long held a foremost place in the technical lectures of the year, and now the Howard lectures bid fair to equal them in interest and importance. The present course of Howard lectures is being delivered on Friday evenings by Prof. W. C. Unwin, upon a subject particularly interesting to electrical engineers—viz., "The Distribution of Power from Central Stations." Elsewhere we give the syllabus of this series of lectures—the first of which was given last Friday. The lecturer commenced by calling attention to that wonderful Lauffen-Frankfort experiment, which has done so much to open the eyes of engineers to the possibilities of transmission by means of high electric pressures. It was explained, however, that the results of this experiment were to be judged from the scientific, and not from the commercial results, yet that the ultimate criterion as to whether this or that system of distribution should be used would be the hard-and-fast commercial question of pounds, shillings, and pence.

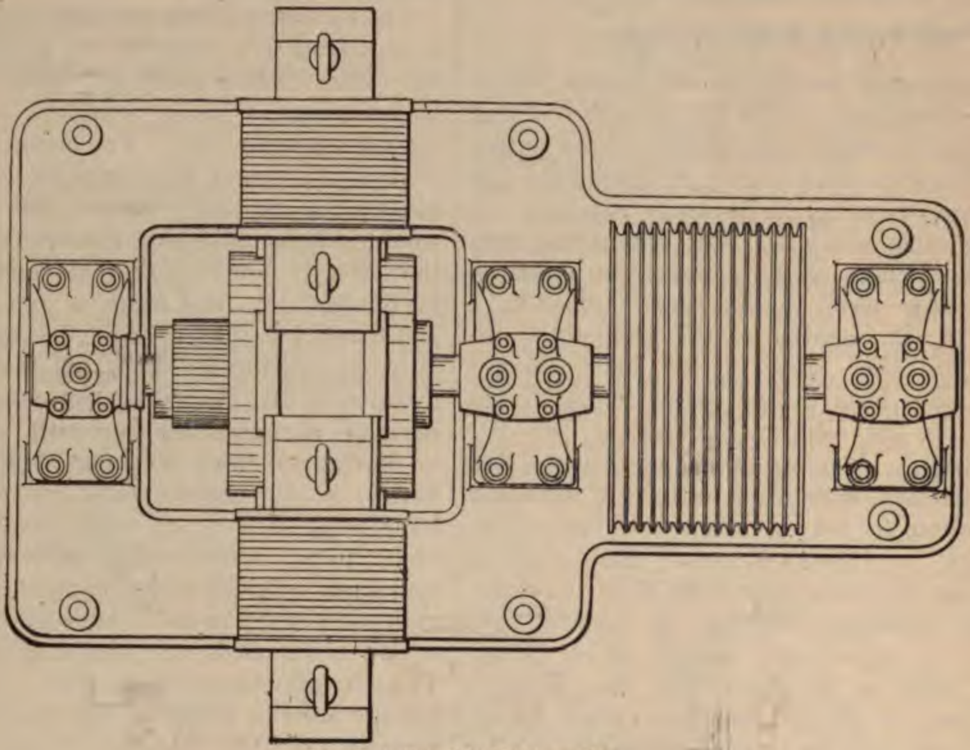
The lecturer pointed out that energy was obtained in three ways: muscular, to be found in animal life; from falling water and natural sources; and from the heat obtained from the burning of solid, liquid, or gaseous fuel. The lecturer explained that time would permit him only to give a part of the information he had prepared, and that the whole would in due course be published in the *Journal* of the society. For the full text, then, we must wait for publication. But there is one important topic just reached at the end of the first lecture to be more fully explained to-night that we may refer to. It is a device by Mr. Halpin to overcome the loss, or a part of it, occurring in central stations owing to having to work so long at light loads. The device is to utilise water in a comparatively large boiler to store up waste heat. The water is under pressure, and as the pressure is relieved so steam can be given off as required. This is but an indication of the method, full details of which will, as we have said, be published in due course. Though extremely interesting, this method of storage must be considered in connection with the statement of Prof. Kennedy at the Civil Engineers on Tuesday night, when he contended that the waste due to the boiler was only 10 per cent., and therefore not so very great under the circumstances. The larger waste was outside the boiler.

BUSINESS DURING 1892.

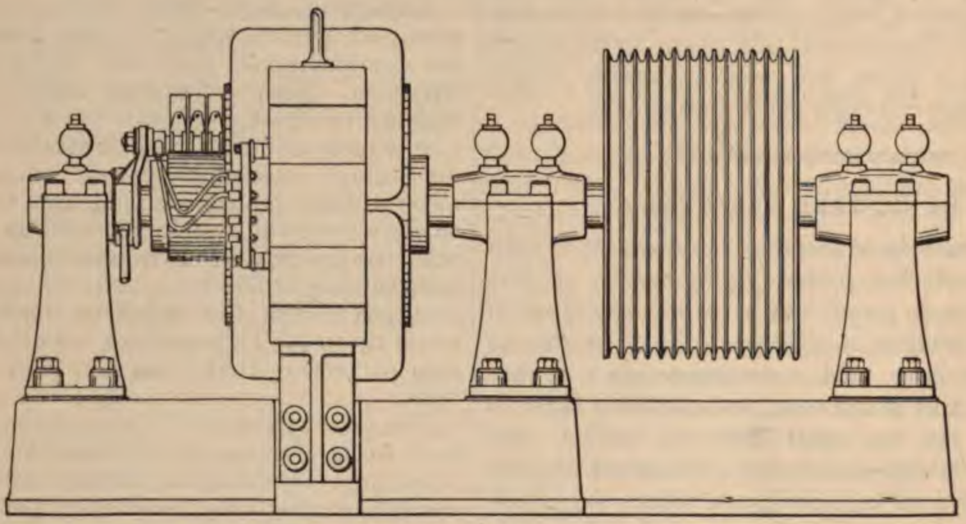
(Continued from page 46.)

CROMPTON FOUR-POLE DYNAMOS.—During the past year Messrs. Crompton have further developed the manufacture of their now well-known four-pole dynamos. They have now made a considerable number of these machines, most of them of large size, which are being used for central-station plant, depositing, smelting, power transmission, and electric welding purposes. Messrs. Crompton have so developed the system of winding that they are able to produce drum-wound machines to work satisfactorily at 600 volts, and combination windings arranged so that the action of the four poles is in series up to the high voltages required for transmission of power—that is to say, from 1,000 to 2,000 volts.

The reasons which led Messrs. Crompton some time back to develop this type of machine have been the following: The four-pole arrangement not only provides for high efficiency and ease of manufacture, but it also reduces the material required, and certainly enables the machines to run at heavy loads with a lower increase of temperature in the windings than is the case with the two-pole form. The machines have been built in all sizes from 50 up to 175 kilowatts for E.M.F's. from 60 to 1,000 volts, and currents up to 2,000 or 3,000 amperes. One size in particular that has been used in colliery work is a 100-h.p. motor for working both above and below ground. Commercial efficiencies have been recorded in actual work of these machines which have been unsurpassed by any machine in the market. The engineer of one of our largest central-station companies has certified that the average combined commercial efficiency of four of these machines, driven by four Willans engines, to be over 84 per cent., which is conclusive evidence that the commercial efficiency of the dynamo taken by itself was at the very least 94 per cent., and this is not the result of isolated tests, but of a large series of tests extending over nearly a year. The armature cores of these machines are constructed in Messrs. Crompton's well-known manner, with the iron discs mounted on bronze radial bars. The conductors are of their patent compressed and stranded bars, the winding being in all cases series coupled, whether it is drum fashion or Gramme fashion. The end connections are built up separately in the form of their patent segmental heads. In all the large sizes for belt or rope driving three bearings are used—these are lined with removable bronze bushes made in halves. The whole machine is very substantially constructed, so as to stand long and continued heavy loads. One large machine has been continually at work from Christmas Day to Christmas Day without interruption, and practically without anything being done to the commutator or brushes.



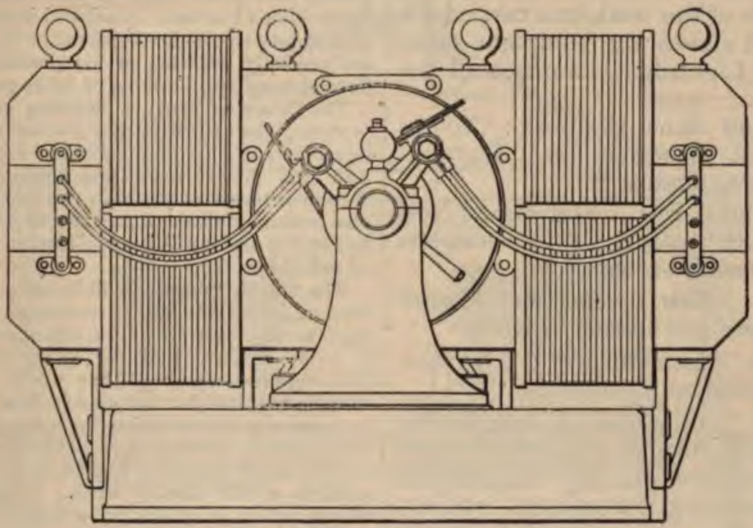
Crompton's Four-Pole Machine.—Plan.



Crompton's Four-Pole Machine.—Elevation.

Messrs. Crompton and Co. have been very busy at their Chelmsford works during the past year. The out-turn of dynamos has been largely increased over that of former years, owing to the introduction of new machinery. Numerous orders for dynamos and motors of all kinds of from 1 h.p. to 50 h.p. have been executed for customers in Great Britain, Australia, Africa, and America. They are now able to keep in stock at least six dynamos of each of their ordinary sizes ready for immediate delivery, and have a large stock of frames ready to be wound to any requirements, and to be delivered at short notice. By increasing the out-turn and the stock of dynamos, Messrs. Crompton have been enabled to very largely reduce the cost of manufacture. A large number of direct-current dynamos up to 200 h.p. have been turned out for various central stations, including the Notting Hill, Birmingham, Hove, and Whitehaven electric lighting companies' stations.

The company have been very busy with transmission plant for collieries, their well-known four-pole type of dynamo having given very great satisfaction in the South Wales collieries in hauling and pumping work, as is evidenced by the numerous repeat orders received. The orders which they have executed include hauling and pumping plant up to 100 h.p. for the Plymouth Colliery Company in South Wales, also Aberdare Colliery, Messrs. Locke and Co., of Normanton, the Pleasley Colliery, and many others. This branch of the business is making very rapid progress, and bids fair to be of great importance. Messrs. Crompton and Co. are making a new departure from their four-pole type of dynamo for large slow-speed direct-current dynamos having eight to ten poles. Several orders are on hand for these, including two for the Great Eastern Railway. A large number of arc lamps have been sold during the past year, and Messrs. Crompton and Co. are now bringing out an improved lamp, which is a modification of the old DD lamp. The old lamp, which has done such good service for many years, is not now equal to modern requirements, but the new one is as good as any in the market, both for parallel and series burning, and in construction is much simpler. They are specially suitable for burning off central-station mains. There are already several hundreds of these lamps on order, and these will be supplied to customers by the end of February. In projectors, Messrs. Crompton and Co. have been turning their attention to making improvements in the Admiralty type, and have designed a projector with a special view to lightness and strength. The chief feature about this, however, is the new Crompton-Pochin automatic search-lamp, which is the simplest and most efficient in the market. A number of orders for these projectors have been received from the Dutch Navy and others. There are prospects of a large amount of business for the coming year. Messrs. Crompton and Co. have now in hand a number of orders for lighting-dynamos, transmission power plant, and motors for the following: Hove Electric Lighting Company, Great Eastern Railway Company, Liverpool-street; Whitehaven Corporation, the Dowlais Ironworks, Messrs. Vivian and Son, the Stanton Ironworks, Messrs. Locke and Co., Normanton; the Southampton Dock, Messrs. Henley's Telegraph Works, and many others, including several large transmission plants for collieries in South Wales, ordered by their agent, J. C. Howell and Co., and a number of dynamos for their agents, Messrs. Corlett and Co. The following are among the most important contracts executed by Messrs. Crompton and Co. during 1892:


Crompton's Four-Pole Machine.—End View.

Messrs. Day, Summers, and Co.: Lighting complete, including Chandler engine and Crompton dynamo, of one of the London and South-Western Railway Company's steamers—"Diana."

Southampton Electric Light Company: Completion of extension contract, including Willans engine and Crompton dynamo, battery of accumulators, and general extension of the mains on to the three-wire system, as well as about half a mile of mains on new frontages.

Wrexham and Acton Collieries: Complete installation of incandescent lamps, part of which are at the pit bottom, including Robey engine and Crompton dynamo; also Crompton motor driving chaff-cutter.

Messrs. Allpress and Belshaw: One small pump and motor for water supply to private house in Kent.

Pleasley Colliery: An extension of the hauling plant, consisting of a small 5-h.p. winding drum driven by a Crompton motor with raw-hide pinion.

W. Garton, Esq., Woolston, Southampton: Gas-engine and dynamo, Crompton-Howell accumulators, incandescent lamps, and small motors for various purposes.

Northampton Electric Light Company: Completion of contract for extension of plant, consisting of new boiler by Daniel Adamson, and one 100-h.p. engine by Scott and Hodgson, direct-coupled to Crompton dynamo, with necessary extensions to switchboard, etc.

Messrs. Albright and Wilson, Oldbury: A laboratory installation, consisting of Crompton-Howell battery, switchboard, meter, and motor for driving various laboratory machines. Battery charged from existing installation.

Messrs. Vickers, Sons, and Co., Sheffield: One 300-ampere 110-volt belt-driven Crompton four-pole dynamo for welding purposes, together with necessary resistances, instruments, and accessories.

Mr. W. Sillery, Wrexham: Dynamo and accumulators for installation for Messrs. Rigby and Son.

M'Ilwaine and M'Coll: Complete lighting of small steamer with Marshall engine and belt-driven dynamo.

B. Dobree, Esq.: Small fan and motor for ventilating kitchen.

Hull Corporation: Contract of considerable size for Crompton underground mains, which has just been satisfactorily completed.

The Labyrinth, Fitzjohn's-avenue, Swiss Cottage: Complete installation, consisting of Crossley's gas-engine and Crompton dynamo, and small Crompton-Howell battery of accumulators, together with all lights and fittings for internal use; also small motor for blowing organ.

The Naval and Military Club: A fair specimen of quick work is illustrated in this particular installation, where the whole of the old plant was pulled out and replaced by two of Messrs. Davey-Paxman's 30-h.p. loco. boilers, two of Messrs. Bumsted and Chandler's 70-h.p. compound engines, direct coupled to two Crompton patent dynamos running at 425 revolutions per minute. The engine-house had to be altered and partly rebuilt, and the whole of this work was absolutely completed in about six weeks from starting, arrangements being so far advanced that the light could actually be supplied a little before this time. Nearly the whole of the interior wiring of the club was also pulled out and completely renewed in the same time. The total number of lights was equivalent to about 600 16-c.p. lamps. The wiring was of a somewhat difficult character, as it was necessary to place all the controlling switches in the various bars, thus necessitating an enormous number of branch circuits. In spite of all difficulties, however, the whole of the work was carried out in the time above stated and to the complete satisfaction of the Electric Lighting Committee of the club.

Messrs. John Riley and Sons, Bradford: Crompton motor driving hoist in warehouse. Supplied from Bradford Corporation mains.

C. W. Dyson Perrins, Esq., Malvern: New switchboard and E.P.S. battery, with complete rearrangement in new battery-room.

Sir Horace Davey: New Crompton - Howell battery fitted up complete and started to work.

H. W. Blake, Esq., Londonderry; Dynamo, cables, and plant for complete installation.

Stanton Ironworks: Completion of installation for lighting general offices, furnace yard, and Stanton Hall. A small installation on the high-tension transformer system, including incandescent and arc lamps.

S.Y. "Vanadis": Complete installation of Crompton dynamo direct-driven by Chandler engine, switchboard, and battery of Epstein accumulators, with all wiring and fittings, for H. O. O'Hagan, Esq. F. Edwards, consulting engineer.

S.S. "Zarate": Complete rewiring and overhauling of plant and fittings for Messrs. Turner, Brightman, and Co.

Messrs. Edwards, Ringer, and Co.: Complete installation, consisting of Crompton dynamo, Crompton-Howell accumulators, incandescent lamps, and one arc lamp in tobacco factory, Bristol.

Didlington Hall, Norfolk: One Crompton shunt-wound dynamo for charging accumulators and driving lights.

Messrs. John Barker and Co.: 2-h.p. motor for driving sausage machine.

Notting Hill Extension Contract: Messrs. Crompton have laid about 2¼ miles of mains, principally of culvert work, for the Notting Hill Electric Lighting Company.

Hove Electric Lighting Company: About 2½ miles of mains were laid, and the temporary generating station equipped. The station contains two 12-h.p. undertype engines and dynamos, one 40-h.p. locomotive boiler, three dynamos, two pumps, a main switchboard, two batteries, and a water-softening apparatus, together with sundry instruments.

AN IDEAL CENTRAL POWER STATION.*

BY C. J. FIELD, E. J. COOK, AND F. BOURNE.

It was with some reluctance that we accepted the title of this paper, realising all that the words imply and the difficulty of fulfilling their requirements. We therefore have tried to carry out the idea as fully as possible by taking as a design a type of station which seems to indicate more fully than anything else the latest and prospective development of the best practice in central power stations.

We will, therefore, take the subject up and divide it into several different heads or divisions, and try in general to indicate, by the plans and specifications illustrated herewith, what we believe to be an ideal central power station, and will treat it by giving a brief general outline of the several points, and close it by attaching to the paper what may be termed a sort of general specification covering the important points—as building, engines, boilers, generators, and piping.

Unit of Power.

The unit of power to be selected for the central power station is one of the first and most important elements to be considered after deciding on the capacity of the station. We have selected for this ideal station 6,000 h.p. as the total capacity. The question immediately arises, How many units of power shall it be divided into? We have found the following as a good rule to follow in deciding on the size of units, and that is, the number of units in any power station shall be the fewest consistent with safe and economical operation of that station. This shall be our foundation-stone to build upon, and should be followed in the broadest possible sense. Experience has too often proved that power stations have been divided into too many units. This has been occasioned largely by two reasons: First, uncertainty of the development of the capacity of the station; and secondly, inability or inexperience of manufacturers in the development and building of large generators.

The business now of building power stations and manufacturing the apparatus has reached such a commercial stage of development that both of these factors are eliminated. We now find capital ready and willing to invest in large power station enterprises, both for railway and general power work; also manufacturers with experience in machinery and ability to develop and build any commercial size of generator required or called for.

The unit of power should be proportionate to the size of the station, and in the size of station we selected we believe a thousand horse-power unit to be one which fulfils our requirements in every respect, both for safety and economy in operation. The engines are so built that where a small amount of power may be required for light loads late at night, the engines can be operated with economy on reduced capacity, even down to a few hundred horse-power. This removes the necessity for one or two small units, as has been customary to instal in some stations of this class of work. They, as a rule, fill the space which could be taken by a larger size generator. A larger number of units proportionately than here laid out means additional expense in handling and caring for the machinery, also additional building space and real estate. The problem is now to concentrate all power into as few units as practicable.

Direct Connection or Belting.

The problem is still in the minds of many people whether to use generators directly coupled to engines, or belted, as in the earlier type of station. Formerly we had no choice in the matter. Generators, except in a few cases, were not built in this country for direct connection work in a commercial sense. We could only belt to the engine directly or through counter-shaft. We do not propose to go into any extended controversy or argument on the three styles of connections, but only point out a few facts to be considered in this connection before deciding.

In a power station of the size herein indicated and located, as would generally be the case, in or about a large city, entailing considerable expense for real estate, and more expense for the building, the problem which at first reaches the engineer's mind is how to concentrate this power within as small a space as is practicable without crowding, and also to economically operate the plant.

Looking at it from this point of view, the relative space required is, roughly, as two to one; in other words, a belted plant would require about five square feet of floor surface per horse-power as against 2½ square feet with direct connection plant. This means a saving of one-half the cost of real estate in building, and also concentration of the power for handling. On the other hand, we have not secured flexibility of connection between the engine and generator, which we have in the belted plant, and the relief to the engine which is afforded by belt against the shocks of short circuits, etc. These are facts which should be more fully considered than they have been in the designing and building of a proper type of engine for direct connection. Ample flywheel capacity is one of the most important requisites for such an engine and ability to withstand direct shocks of short circuits and overloading of the generators. When these problems have been fully met, both theoretically and practically, we have no doubt that the development of the direct connection station will be rapidly extended. At present we are just beginning to enter what might be termed the era of direct connection work commercially, having as a basis for experience small practice in this country in special cases and a more extensive practice in Europe in this line.

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* Paper read before the Chicago Electric Club, Dec. 19, 1892.

POWER-STATION BUILDING.

For power-station building there are shown in Figs. 1, 2, and 3 general features and details of construction of a building adapted for this style and capacity of station.

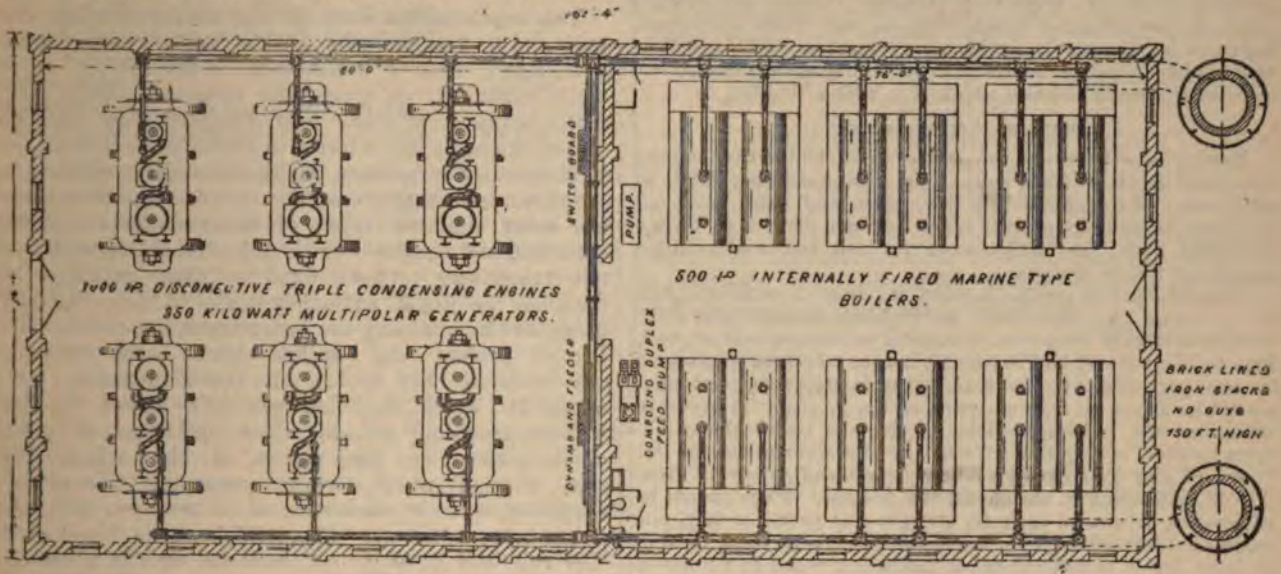
162'-4"
60'-0"
76'-0"
SWITCH BOARD
PUMP.
1400 HP. DISCONECTIVE TRIPLE CONDENSING ENGINES
350 KILOWATT MULTIPOLAR GENERATORS.
500 HP INTERNALLY FIRED MARINE TYPE BOILERS.
DYNAMO AND FEEDER
COMPOUND DUPLEX FEED PUMP
BRICK LINED IRON STACKS NO GUYS 150 FT. HIGH

FIG. 1.

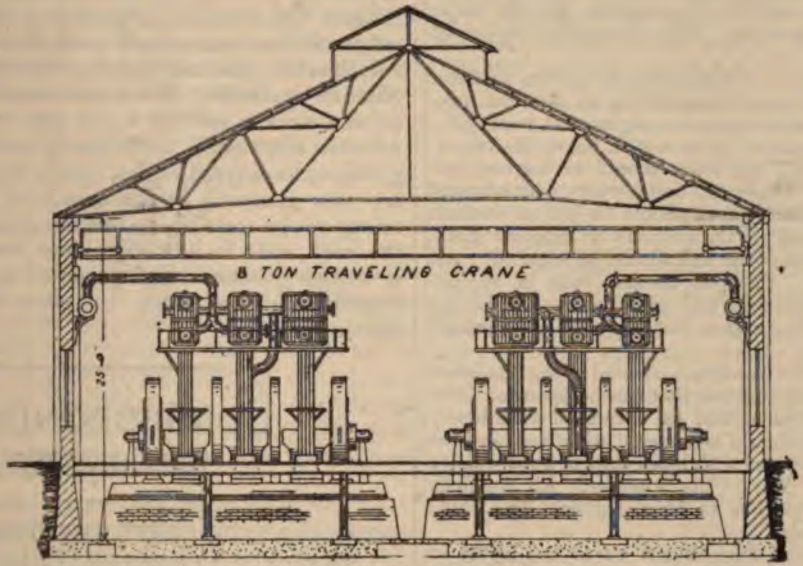

FIG. 2.

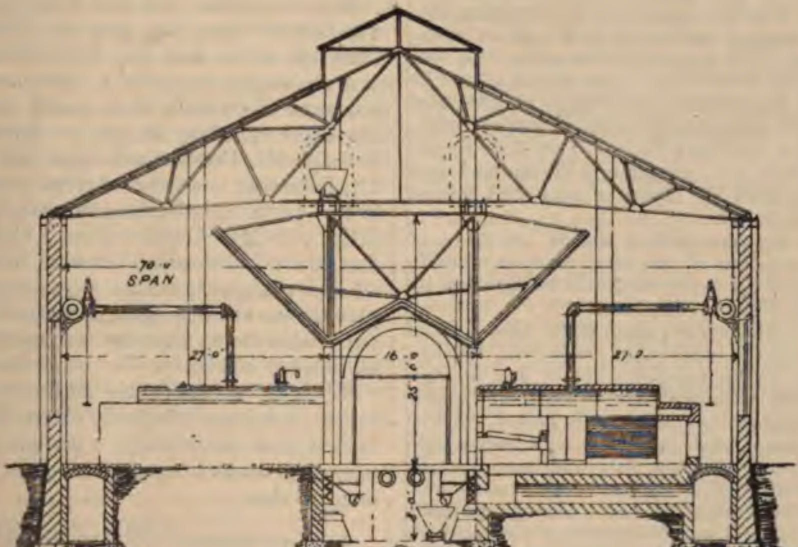

FIG. 3.

The power-station building is a factory for producing a commercial commodity and should be treated in that sense, the essential requirements being solidity of construction and protection against fire or any other accident to the machinery contained therein. The design of these buildings is too often placed in the hands of local architects, inexperienced and unacquainte with the requirements of such a building, and we find as a result many power stations in which the machinery has to be placed to fit the building, instead of, as it should be, the machinery laid out and the power station built to cover and properly protect it; being built, therefore, from an engineering point of view instead of an architectural one. Without attempting to go into details or producing a regular building specification, we have tried, under the head of "Building Specifications," to cover the main features required in such a building.

Building Specifications.

Excavation.—Excavate the entire space under the engine-room to a depth of 10ft., so as to get clear headroom of 8ft. in basement. Excavate for all side, cross, and gable walls, all foundations, and also central space between boilers to form a basement under the boiler-room for ash and coal-handling apparatus, flue, and pipes.

Foundations.—If ground is good, lay base of concrete (four broken stone, two sharp sand, one hydraulic cement) and make footing-courses of brickwork or coursed rubble masonry of good, firm building stone, laid in cement mortar of three parts sand to one part cement. In case piling is necessary, test piles should be driven on different parts of the property in order to determine the bearing capacity of the pile under the conditions present, noting the amount the pile sinks under the last blows of the "monkey." Allow a factor of safety of from 4 to 15, depending on the conditions present. Piles should be of hemlock or spruce, perfectly straight and round, a 40ft. pile having not less than a 12in. butt—the piles, after being driven, to have heads sawed off below mean low water to a uniform level; all piles in water to be capped with granite foundation-stone, while those with heads in earth to be capped with a grillage of 12 by 12 spruce and 3in. plank timber, and the whole filled with concrete well rammed. Lay foundation proper on this grillage.

Walls.—All walls should be of brickwork from 16in. to 20in. thick, with pilaster at each roof truss, having at least 8in. projection and 24in. face. Carry these to a height of at least 25ft., so as to allow clear headroom of at least 20ft. below the travelling crane in power-house. All brick should be burned and should have clean, sharp edges, no salmon or light-coloured bricks being allowed. All brickwork should be laid in cement mortar. The cement should be Dyckerhoff's or English Portland. All bricks in the face of the wall should be selected. All joints should be pointed. Pilasters on side walls of engine-room should be built out by offsets and capped with stone binder for carrying rails of travelling crane. Set side ventilators in wall near ground line.

Roof.—The roof should be iron-truss, riveted type, furnished with iron louvre, with side ventilator that can be operated from the floor. The top of louvre should be furnished with heavy hammered glass. The roof should be covered with Norway pine plank, splined and then covered with black slate of good quality laid with not more than 5in. to the weather. All flashings around walls and all gutters to be of 16oz. copper. The whole to make a weather-proof job.

Engine Floor.—The engine floor should be of two layers of plank, the first of yellow or Norway pine splined with hard wood, this floor to be covered with about $\frac{1}{8}$in. of plaster, and then with a second floor of $\frac{7}{8}$in. second quality maple laid at right angles to the first. The first plate to be not less than 8in. or more than 12in., and securely bolted by hook-bolts at every beam to the iron I beams. The second floor should not be over 4in. in width and should be blind nailed. All planks should be neatly fitted about all foundations, and hand planed, and smoothed, and finished with two coats of boiled oil put on warm.

Engine and Boiler Room, Basement Floor.—This floor should be made of not more than 6in. concrete, well rammed and graded to drain, and finished by means of fine stuff floated smooth by means of hand trowel.

The boiler-room floor between boilers should be made of steel I beams, covered by means of cast-iron plates of suitable pattern. All other parts of the fireroom should be finished by means of concrete cement, same as basement.

Doors and Windows.—All floors or main doors should be of some wood ceiling, and made, say, $2\frac{1}{2}$in. thick, and finished with large wrought-iron hinges (oxidised hinges and knobs). All doors in cross or partition walls should be made of beaded white-pine ceiling laid diagonally and securely nailed, covered with a layer of asbestos board, and then entirely covered with black sheet iron fastened by means of round-headed nails. These doors should be sliding with friction rollers, tracks, etc. All windows should have box frames, all sashes having four lights of American glass, best quality, well bradded and back puttied, fitted with noiseless pulleys, cast-iron weights, brass chains and sash locks.

Painting.—All woodwork should have not less than three coats of first-class lead paint ground in oil; this includes under side of roof, windows, doors, etc. All iron should receive two coats of metallic paint, one before erection and one after the structure is completed.

(To be continued.)

REVIEWS.

Telephonie Pratique. L. Montillot (A. Grelot, Paris).

This is a laborious work on the details of telephony as practised in France. The author takes a restricted and local, rather than a broad, view of his subject, so that, while calculated to guide the technical officers of the Administration of Posts and Telegraphs in their daily duties, the book is not likely to excite much interest north of France. For instance, M. Montillot gives elaborate and well-executed diagrams of the details and connections of the many different types of instruments—transmitters, receivers, and ringers—which the French regulations permit subscribers to have fixed on their exchange lines, drawings no doubt extremely useful to those engaged in fixing and maintaining the instruments, but to few besides. In his preface the author states that throughout the book he has spoken of the instruments by the names by which they are generally known in France without troubling himself about questions of priority of invention or the names of the actual inventors, a plan which, while possessing the merit of simplicity, scarcely reconciles us to a Gower-Bell microphone being called the "Microtéléphone de M. Bancelin." The rule laid down is not, however, strictly adhered to, since the invention of the transmitter induction coil is expressly, although of course erroneously, ascribed to Edison. In switching matters it is evident that American influence has made itself powerfully felt in France, the switch-table described showing little deviations from trans-Atlantic methods. The information given about underground work is scarcely up to date, since paper cables are not even mentioned, while nearly two pages are devoted to guttapercha-covered cables, which for telephonic purposes are now generally ranked amongst the antiques. As a record of the state of the telephonic art in France in 1892 the work, with its 414 engravings, has a distinct value, but it neither discloses nor proposes anything new, and is consequently not likely to effect any modification of existing practice.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMPARATIVE EFFICIENCIES OF GAS-ENGINE GENERATED ELECTRIC LIGHT AND ORDINARY GASLIGHT.

Sir,—I notice that Mr. Emerson Dowson states that it was believed that the late Sir William Siemens first drew attention to the fact that when illuminating gas was burnt in a gas-engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Perhaps Mr. Dowson will give his reasons for this belief. The following is extracted from a report on the distribution of fuel-power gas, bearing the names of Mr. B. H. Thwaite, C.E., and Mr. Dugald Clerk, C.E., and is perhaps the first printed statement showing by calculation the superior efficiency of gas burnt in a gas-engine, and the power converted into electric light, compared with ordinary burners; but it also shows that the recuperative gas-burners have a still higher efficiency.

"It will be interesting and instructive to compare the thermo-luminous efficiency of gas burnt direct at the gas-burner, and also burnt in a modern gas-motor; the dynamic energy produced being afterwards converted into luminous energy, thus:

1.	2.	3.
Thermo-dynamic.	Dynamo-electric.	Electroluminous.
Transformation.	Transformation.	Transformation.
Gas-motor.	Dynamo.	Incandescent.
		Electric light.

"For the comparison, a lighting power equivalent to 510 16-candle lights is assumed to be burning for a period of one hour. The electric light equipment consists of an efficient gas-motor; the insulation of the leads is fairly perfect, and they show a loss of only 2 per cent. The dynamo is assumed to realise 75 per cent. of the dynamic power supplied to it.

Summary.

510 incandescent carbon filaments in vacuo lamps, each of 60 watts, or, say, equivalent to 16 candles	30,600 watts.
Loss in leads	31,300 „
To compensate for 75 per cent. of efficiency, or a loss of 25 per cent.	39,100 „

"Assuming this watt output to absorb 52·6 i.h.p., then, accepted 20 cubic per indicated horse-power, the consumption of gas per hour equals $52·6 \times 20 = 1,052$ cubic feet. Then the number of candles of photometric value obtained per cubic foot of gas burning one hour, would be equal to $(510 \times 16) \div 1,052 = 7·7$ candles per cubic foot of gas burnt in the gas-motor cylinder. Ordinarily, 16-candle gas burnt at the rate of five cubic feet per hour will give an open-flame light of a luminous value of 12 candles. Hence, $12 \div 5 = 2·4$ candles per cubic foot per hour. An inverted recuperative gas lamp will give, with a consumption of five cubic feet per hour, a light equal to 40 candles. Then, $40 \div 5 = 8$ candles per cubic foot per hour. And an incandescent gas lamp of the latest improved form may be taken to give, with the same consumption of gas, a light equal to 50 candles; then, $50 \div 5 = 10$ candles per cubic foot per hour."

The ratio, according to this data, is as 2·4 is to 7 in favour of the electric light. Mr. Dowson's figures give a ratio of as 2·5 is to 5, but he uses a standard argand burner; if the comparison was made with the ordinary batswing burner, the ratios will approach each other closely.—Yours, etc.,

JAS. W. VICKERS, Student Inst. C.E.

153, Kingsley-road, Prince's Park, Liverpool.

MULTIPHASE TRANSMISSION OF POWER.

SIR,—In the controversy which has been going on in your pages between Messrs. B. H. Thwaite and F. T. Eggers, with regard to the Lauffen-Frankfort transmission experiment, my name has been mentioned. This induces me to make the following remarks in the hope of correcting a misapprehension as to the purpose of this experiment arising from somewhat interested representations with regard to the part played therein by the three-phase system.

The experiment was undertaken to demonstrate on a practical scale the feasibility of long-distance power transmission at high tensions by means of bare overhead conductors.

By preliminary experiments before a committee of electricians, and a lecture which I delivered at Frankfort early in 1891, I convinced the electrical world of the practicability of the scheme sufficiently to obtain the necessary capital for its demonstration on a large scale between Lauffen and Frankfort. It was at first intended to employ single-phase alternate currents, but as it happened that a three-phase machine with transformers was ordered for the Lauffen station for the light and power distribution at Heilbronn, it was decided to employ them in these experiments, especially in order to show the advantages of the three-phase system—viz., power distribution by means of simple self-starting motors. It must be repeated that this experiment, so far from demonstrating these advantages, actually showed the disadvantages of the system—viz., complication in line, generator, and transformers—so that instead of being the purpose of the experiment, the three-phase system was actually one of the difficulties to be contended with.—Yours, etc.,

C. E. L. BROWN.

Baden, January 10, 1893.

NAME OF FIRM.

SIR,—I notice in the electrical and building papers a statement that the company known as Roger Dawson, Limited, has been formed to acquire the business of Rashleigh Phipps and Dawson.

As this is calculated to be very detrimental to the public and also to my interests, I beg to inform you that, under the terms of the dissolution between myself and Mr. Dawson, the deed provides that neither partner shall use the name of the other in any shape or form whatever.

I am now carrying on business at 102, Oxford-street, under the style of Rashleigh Phipps and Co., electrical engineers, and my business will be in no way affected by the company which has been formed.—Yours, etc.,

A. RASHLEIGH PHIPPS.

SKATING BY ELECTRIC LIGHT.

SIR,—Referring to remarks in your issue of 13th inst., page 49, and signed by W. P. Steinthal, I should like to claim for Morrison Lough, Cambuslang, by Glasgow, as being the first skating pool to which electric lighting was introduced. To Cambuslang, skating with aid of electric light is over five years old.—Yours, etc.,

W. MITCHELL.

283, Wightman-road, Hornsey, N.,
13th January, 1893.

COMPANIES' REPORTS.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

Directors: Eustace J. A. Balfour, Esq., chairman; H. Woodburn Kirby, Esq., vice chairman; Gerald W. Balfour, Esq., M.P.; Latimer Clark, Esq., F.R.S.; Sir John H. Morris, K.C.S.I. General manager and secretary: Frederic J. Walker. Chief engineer: S T. Dobson, A.M I.C.E., M.I.E.E.

Report of the Directors and statement of accounts for the year ending December 31, 1892, to be submitted to the meeting on January 24 at the Central Station, Carnaby-street, Golden-square, at 3 o'clock

The Directors beg leave to submit their annual report for 1892, the accounts accompanying the same being duly certified by the Company's auditors. Owing to difficulties with regard to ancient lights and other matters, it was found impossible to complete the northern central station within the time contemplated. It is now, however, practically finished and complete with sufficient machinery for the supply of 20,000 8-c.p. lamps, which, when necessary, can be augmented by further plant, raising the capacity of the station to 65,000 8-c.p. lamps. The two stations are already connected by the great trunk main, and within a very short time they will not only be able to run concurrently, but will be able to relieve each other should necessity arise. The Directors are pleased to be able to report that the plant at the southern central station is in perfect order, and fully maintains the efficiency and economy noted last year. It has, unaided, produced the income shown in the accounts. The Directors have devoted great attention to the curtailment of all unnecessary expenditure, in which they have been ably seconded by the officers and staff of the Company. Their policy has, however, been that of maintaining the buildings, plant, and mains of the Company in the highest state of efficiency. They are not only advised, but their experience has satisfied them that to earn continuous dividends in a business of this character, liable as it is to many risks, and dependent on the correct handling of multitudinous details, it is essential that the whole of the Company's works and mains should be thoroughly maintained in every respect. The whole of the compulsory mains are now laid, and this, together with the amounts required for the completion of the new station, has caused a large capital expenditure during the year, which has as yet produced no corresponding income. The Directors are happy to state that the works have been completed at a cost well within the estimates, and they do not anticipate that any further capital will be required unless a demand should arise for current in excess of the Company's present capacity. The question of the "redemption fund," inaugurated last year, is one which has been prominently brought to the attention of the Directors by certain holders of founders' shares, who consider that the amount is improperly taken from "revenue account," and should be divisible as profit amongst the shareholders. This question was before the meeting of the members of the Company last year, when the creation of the fund was approved of *nem. con.* The Directors therefore recommend that this policy be maintained, believing that it is one which will meet with the continued approval of the shareholders. In their judgment, the establishment of this fund is prudent, and they are advised that it is in strict accordance with law. The Directors regret to announce that the action brought against the Company by Dr. John Hopkinson, for the alleged infringement of his three-wire patent, has been decided against the Company. Pending the consideration of whether the Company should appeal, they are glad to be able to state that they have completed arrangements whereby they will be in a position to continue the supply of current without interruption, and without further use of the patentee's system. The Company will not have to bear the whole of the costs of the action. The net earnings of the Company during the past year have amounted to £14,598. 19s. Of this sum £5,997. 10s. was distributed in July last in payment of an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30, 1892, on the ordinary shares, and at the rate of 7 per cent. per annum on the preference shares. The balance, £8,601. 9s., together with the undivided profits of £22. 12s. 2d. from last year's account, leaves £8,624. 1s. 2d. now to be dealt with. The Directors propose to divide this amount as follows :

	£	s.	d.
(A) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	£3,500	0	0
(B) By payment of a dividend at the rate of 9½ per cent. per annum for the second half-year on the ordinary shares, making, with the interim dividend paid in July last, a total distribution of 7¼ per cent. for the year	4,745	5	0
(C) By paying a dividend of £3. 3s. per share on the founders' shares	315	0	0
(D) Amount to be carried forward to ordinary shareholders' undivided profit account	59	7	0
(E) Amount to be carried forward to founders' undivided profit account	4	9	2
	£8,624	1	2

The Directors have carried £1,000 to increase the redemption fund, which, with the addition of interest received during 1892, now stands at £2,029. 6s. 4d., and which is accumulating by annual additions towards representing loss of capital at the expiration of the term covered by the provisional order. The Directors are advised that the amounts provided in the accounts for depreciation are sufficient and ample for all purposes. The Directors regret that Mr. Charles Showell, one of their number, found it necessary to resign his seat on the Board owing to his numerous engagements. They elected Mr. Gerald W. Balfour, M.P., brother of the chairman, to fill the vacancy thus created, being of opinion that his services would be of great value to the Company. Sir John H. Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P., retire under Clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

CAPITAL ACCOUNT.

The capital authorised and received is £200,000, of which £14,670. 6s. 2d. remains unexpended.

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31, 1892.

A.—To Generation and Distribution of Electricity.

Dr.		£ s. d.	£ s. d.
Coal and other fuel, including dues, carriage, etc.		4,673 14 11	
Oil, waste, water, and engine-room stores		590 18 2	
Salaries of engineers and officers		856 1 2	
Wages at generating and distributing station		2,912 11 0	
Repairs and maintenance, as follows :			
1. Buildings	£219 16 3		
2. Engine and boilers	803 14 2		
3. Dynamos	58 16 5		
4. Other machinery, instruments and tools	90 9 8		
5. Accumulators	2 6 7		
6. Lamps (at station).	33 16 11		
		1,209 0 0	
Repairs and maintenance of mains		963 15 11	
Miscellaneous expenses		62 0 3	
			11,268 1 5
B.—To Rents Rates, and Taxes.			
Rents payable		479 11 0	
Rates and taxes		338 10 9	
			818 1 9
C.—To Management Expenses.			
Directors' remuneration		1,622 2 0	
Salaries of general manager and secretary, engineer, clerks, etc.		1,654 10 7	
Stationery, printing, and advertising		166 9 4	
General establishment charges		170 14 4	
Auditors of Company		52 10 0	
			3,666 6 3
D.—To Law and Parliamentary Charges.			
Law expenses			284 10 6
E.—To Special Charges.			
Insurance		109 15 10	
Broker's charge for obtaining Stock Exchange quotation		21 0 0	
Fees for testing meters		3 15 0	
Board of Trade audit		59 0 0	
			193 10 10
F.—To Depreciation.			
Depreciation on buildings		285 8 10	
Depreciation on plant, machinery, etc.		3,584 6 2	
			3,869 15 0
G.—To Redemption Fund.			
Provision for recoupment of capital expenditure			1,000 0 0
			21,100 5 9
Balance carried to net revenue account			13,458 19 5
			£34,559 5 2

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts.	33,397	4	1
Rental of meters on consumers' premises	546	5	0
Rents receivable	401	18	10
Transfer fees	90	15	0
Discounts on purchases	71	16	6
Sale of old materials, stores, etc.	48	3	4
Sundry fees, shareholders' lists sold, etc.	3	2	5
	£34,559	5	2

GENERAL BALANCE-SHEET, DEC. 31, 1892.

Dr.		£ s. d.
Capital account—		
Amount received		£200,000 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.		2,467 8 3
Sundry creditors on open accounts		1,383 16 1
Unclaimed dividends		3 2 6
Capital reserve fund		15,000 0 0
Redemption fund		2,029 6 4
Net revenue account—		
Balance at credit thereof	£14,621 11 2	
Less interim dividends paid on ordinary and preference shares	5,997 10 0	
		8,624 1 2
		£229,507 14 4

Cr.		£ s. d.
Capital account—		
Amount expended for works		185,329 13 9
Law charges in suspense (*re* three-wire action)		654 0 0
Stores on hand—		
Coal	£735 4 0	
Lamps	37 10 1	
Meters and switches	548 2 9	
General, including oil, waste, etc.	1,869 11 3	
		3,190 8 1
Sundry debtors for current supplied	10,753 10 5	
Other debtors	211 3 6	
		10,964 13 11
Cash at bankers (Lloyd's Bank, Limited), including deposit of £12,000	13,312 8 11	
Cash in hand	27 3 4	
		13,339 12 3
Capital reserve fund investment, 2½ per cent. annuities		15,000 0 0
Redemption fund investment, Bank of England stock		1,029 6 4
		£229,507 14 4

NEW COMPANIES REGISTERED.

Herculite and Electrical Manufacturing Company, Limited. Registered by Saunders and Co., 68, Coleman-street, E.C., with a capital of £12,000 in £1 shares. Object : to adopt and carry into effect an agreement expressed to be made between J. Long of the one part, the Herculite Manufacturing Company, Limited, of the second part, and this Company of the third part, and to manufacture herculite and other electrical apparatus. There shall not be less than three nor more than five directors ; the first to be elected by the signatories to the memorandum of association. Qualification, 100 preference or 250 ordinary shares. Remuneration, £300 per annum, divisible.

Printing Telegraph and Construction Company of the Agence Havas, Limited.—Registered by Slaughter and May, 18, Austin-friars, E.C., with a capital of £130,000, divided into 26,000 £5 ordinary shares. Object : to acquire by purchase or otherwise the right to use and vend within the Republic of France certain inventions relating to printing telegraphs, whether covered by patent, provisional specification, or not ; to carry into effect certain agreements—the first made between Robert D. Radcliffe and Laur von Viben-Smith of the first part and this Company of the second part ; the second made (in the French language) between the Agence Havas (a French société anonyme) of the first part, R. D. Radcliffe and Laur von Viben-Smith of the second part, and this Company of the third part, with or without modification, but so that so long as such agreement shall be in force the sum of £20,000 (part of the capital) shall be appropriated and applied only in the manner and for the purposes specified in such agreement, except with the consent in writing of the Agence Havas, and to carry on in France, in conjunction with the Agence Havas, the business of transmitting the news of the day to subscribers, and to deal in all things incidental to improvements in telegraphy in France. The first signatories are :

	Shares.
T. E. Polden, 2, Amen-corner, E.C.	1
W. Seymour, 9, Ovington-square, S.W.	1
W. A. Pittman, 3, Summerland-villas, Harlesden	1
P. W. Bullock, 22, Upper George-street, Bryanston-square, W.	1
W. H. Stentiford, 3, Sevington-street, Maida-vale, W.	1
E. R. Polden, 2, Amen-corner	1
W. J. Watchurst, 20, High-street, New Brompton, Kent	1

There shall not be less than three nor more than seven directors ; the first to be elected by the signatories. Remuneration to be fixed by the Company. Qualification, £500.

Pyke, Harris, and Co., Limited.—Registered by Fowler and Co., Limited, 28, Victoria-street, S.W., with a capital of £30,000 in £5 shares. Object: to acquire as a going concern the business of Messrs. Pyke and Harris, electrical engineers, and to develop and carry on the same. E. Prentice and L. S. M. Harris are the managing directors, their remuneration as such being £350 each per annum, and a percentage of the profits. Ordinary directors to be appointed by the signatories to the memorandum of association. Qualification, £200. Remuneration, £100 per annum each and a percentage of the profits.

Stephens and Co., Limited.—Registered by Close and Co., 23, Great Marlborough-street, W.C., with a capital of £20,000 in £1 shares. Object: to acquire the business of an electrical engineer now carried on by J. Stephens at Cuba-street, Millwall; to acquire certain machinery from G. Statter and Co.; to carry into effect an agreement made December 12, 1892, between J. Stephens of the first part, J. G. Statter and Co. of the second part, and this Company of the third part; and to carry on, in all their respective branches, the businesses of electrical, mechanical, and general engineers. First directors: J. G. Statter, H. S. Price, and John Stephens. Remuneration: John Stephens (managing director), £400 per annum; J. G. Statter, £100; remuneration of H. S. Price to be determined by J. Stephens and J. G. Statter.

Waterhouse Electrical Manufacturing Company, Limited.—Registered by Russell and Arnhotz, 17, Great Winchester-street, E.C., with a capital of £20,000 in £10 shares. Object: to carry into effect an agreement expressed to be made between A. G. Waterhouse of the first part, J. H. Gamble and F. T. Chambers of the second part, and R. Bolton of the third part, and to carry on the business of an electrical manufacturing and supply company in all its branches. The first directors are R. Bolton, A.M.I.C.E., and A. F. Salisbury-Jones, and an advising Board in America consisting of F. T. Chambers, J. H. Gamble, and F. E. Waterhouse. Qualification, £100. No remuneration. Managing director, Reginald Bolton, his remuneration being £250 per annum and a percentage of the profits.

BUSINESS NOTES.

Carbons.—Ten tons of retort gas carbon for electrodes will be found advertised elsewhere by the Aldershot Gas Company.

West India and Panama Telegraph Company.—The receipts for the half-month ended January 15 were £2,522, against £2,321.

Morpeth.—Notice has been given to the Morpeth Town Council to consider the desirability of having the town lighted by electricity.

Fleetwood.—Mr. Miller, consulting engineer to the Fleetwood Commissioners, is expected to report on the electric lighting tenders this week.

Edison-Swan Company.—This Company have opened new works at South Benwell to meet the increased demand for their manufacture of fittings.

Cape Cables.—The Eastern Telegraph Company, Limited, notifies that submarine telegraph communication is restored to the Cape of Good Hope and South Africa.

Popular Electricity.—The *Glasgow Herald* has begun a series of articles on "Electricity as an Illuminant," of which the first article appeared in the issue for the 14th inst.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,664.

Warminster.—An electric light is to be placed on the Morgan Memorial Fountain at Warminster, with the view of ascertaining the advisability of having a second electric lamp on the top of Town Hall Hill.

St. James's and Pall Mall Electric Light Company, Limited. The directors of this Company recommend a dividend at the rate of 9½ per cent. per annum on the ordinary shares for the half-year ending December 31, 1892.

Budapest.—A telegram from Budapest states that a financial group at Vienna is engaged upon the formation of a company which would light the Hungarian capital by electricity. The capital has been fixed at £250,000.

Shoreditch.—Mr. E. Manville has been elected consulting electrical engineer to this Vestry at a fee of 30 guineas, on the understanding that it does not bind the Vestry to appoint him subsequently engineer to the Vestry.

Murton.—A correspondent of the *Newcastle Daily Chronicle* points out that at Murton junction the railway company have a stationary engine for pumping which could also be used for electric light, as they have no gas at this station.

Concert.—Last Friday the third staff smoking concert in connection with the City of London Electric Lighting Company took place at Mason's Hall Tavern, Mason's-avenue, Mr. G. H. Nisbett in the chair, and an enjoyable evening was spent.

Installations.—Among other work in hand, Messrs. Pyke, Harris, and Co., Limited, are putting in the wiring and fittings for the New Zealand Government Offices, Victoria-street, S.W., and William Lucas, Esq., Ryder-street, St. James's.

European Agency.—Messrs. Mackey, Mackey, and Co., of 1 and 2, Bouverie-street, E.C., have been appointed agents for Messrs. Waite and Bartlett, manufacturers of electro-medical and electro-surgical appliances, of which we have received catalogue.

Rotten Telephone Wires.—A curious case was stated at Luton last week, where the fire brigade telephone line, which was of steel, had corroded and become perfectly rotten in three years. It was thought this was due to the sulphur in the air, and a copper wire was ordered to replace it.

Ilford.—At the meeting of the Ilford Local Board on the 10th, the clerk said he had been in communication with several electric light companies, and the Brush Company had offered to send down an expert free of charge, but this would only be to report as to the lighting of houses.

City and South London Railway Company.—The receipts for the week ending January 15 were £1,007, against £836 for the corresponding period of last year, or an increase of £171. The total receipts for 1893 show an increase of £311 over those for the corresponding period of 1892.

Kimberley Exhibition.—Messrs. Johnson and Phillips have been awarded a gold medal (highest award) for their dynamos at the Kimberley Exhibition, South Africa. The machine was exhibited by Messrs. Edlin and Stevenson, of Cape Town, their general agents in that part of the world.

Aberdeen Railway Station.—The Great North of Scotland Railway Company contemplate lighting the Aberdeen railway station by electric light, and an experiment has recently been conducted by a Glasgow electrical engineer. The station and hotel will probably be fitted with the light.

Direct United States Cable Company, Limited.—This Company recommend an interim dividend of 3s. 6d. per share, tax free, being at the rate of 3½ per cent. per annum, for the quarter ending December 31, payable on the 28th inst., placing £4,000 to reserve fund account and carrying forward £3,129.

Bath.—The electric light company at Bath are intending to place a special voltmeter in the works to enable them to tell at once whether a light was out in this or that circuit. On any indication they would send their inspector to spot the particular lamp which was in default, and to remedy the defect.

Redditch.—At last week's meeting of the Redditch Local Board, Mr. W. Gibbs moved that a committee be formed to consider and report upon the advisability of having at least the central portion of the district lighted by electricity, and that an expert be called in, and his opinion obtained as to cost.

Blackpool.—The Blackpool Electric Lighting Committee expect to have their new plant in working order by Whitsuntide. Mr. W. Challoner, a local man, intends to undertake the supply of the various electric light fittings, and has engaged an experienced electrical engineer to take charge of the installation work.

Kingswood.—Complaints have been made of the Kingswood electric light, which is carried on, if we remember, by 16-c.p. lamps, as at Barnet. On the other hand, a memorial was read from other districts to extend the blessing to them. Feeling ran so high that the surveyor tendered his resignation, but afterwards withdrew it on receipt of a vote of confidence.

Dinner.—The service of cars on the Bristol-road tramway route at Birmingham was suspended early one day last week to allow of the men engaged on the electric system attending their annual dinner at the Bournbrook Hotel. About 70 men—drivers, conductors, and depôt employés—were present, and a pleasant evening was spent. Mr. T. Goodyear, assistant traffic manager, presided.

Newcastle.—At the meeting of the Newcastle City Council last week, consent was asked to an application by the Newcastle-upon-Tyne Electric Supply Company to the Board of Trade for a provisional order authorising the company to supply electricity under the Act of 1882 for public and private purposes within the area of the city and county of Newcastle-upon-Tyne. The Council agreed to the application.

Appointment Open.—The Heckmondwike Local Board require a practical and efficient electrical engineer to prepare plans and estimates and carry out the work required in the electric lighting of Heckmondwike, according to provisional order. Applicants must state full and inclusive terms, with copies of testimonials as to ability, to Mr. Dixon S. Sykes, clerk to the Board, by Wednesday next, the 25th inst.

Dewsbury.—At the Dewsbury Town Council meeting on the 12th December, the Lighting and Water Committee's minutes stated that reports and a specification by Mr. Preece on the electric lighting were approved. They record the establishment of the central station at the old gasworks, that the plant be made for the supply of 10,000 lamps of 35 watts and be capable of expansion. These minutes were adopted.

Windsor.—The Windsor Electric Light Company having broken the streets without permission and been fined for it, have asked permission for the next time. This caused an excited discussion at the Town Council, the town clerk objecting, drawing a harrowing picture of liability in case anyone's leg was broken when the streets were up. Eight voted for and eight against, and the Mayor gave the casting vote for the affirmative.

Allerton and Heaton.—At the last Bradford Town Council meeting, Mr. Freeman moved a resolution instructing the Gas and Electricity Supply Committee to take steps at an early opportunity with the view of acquiring the right of supplying gas in the townships of Allerton and Heaton, and the hamlets of Thornbury and Tyersal. The resolution was ultimately withdrawn, on the understanding that the matter would be brought up in the committee.

Gold Medals Awarded.—Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, Close Works, Newcastle-on-Tyne, have been awarded a gold medal for the electric lighting of the Sheffield Trades Exhibition, and also a gold medal for the electric lighting of the Lincoln Trades Exhibition. In both cases the exhibition was lighted by one of Messrs. Scott and Mountain's latest type two-pole Tyne compound-wound dynamos, feeding 10-ampere Tyne arc lamps, the lamps being run in parallel.

Burlington House.—The Royal Chemical Society at Burlington House has just had the electric light laid on throughout the whole of the premises facing Piccadilly. At the recent first winter meeting, Sir Henry Roscoe, M.P., in the chair, the treasurer stated that the society was under a special obligation to Prof. Ayrton for the thought and energy he had expended on the work. He also considered that the fittings designed by Messrs. Faraday and Son, did credit to the reputation of that firm for artistic work.

The Indo-European Telegraph.—The Secretary of State has accepted the proposal of the Government of India to separate the Indo-European from the Indian Telegraph Department. It is proposed, says the *Indian Engineer*, to place the line under the direct control of the India Office, an officer being appointed at a salary of £1,000 a year in charge of the department, with his headquarters in London. He will probably be chosen from the Indian Telegraph Department, as experience in the East is mainly what is required for the new post.

Kingston-upon-Thames.—The Kingston Corporation invite tenders for the necessary plant and mains for the supply of electricity in the borough, in accordance with the specification, plan, and form of tender, which can be obtained from Mr. Harold A. Winser, town clerk, Kingston-on-Thames, after Tuesday next, the 24th inst. The person or firm whose tender is accepted will be required to enter into a contract and a bond, with two approved sureties, for the due performance of the contract. The tenders are to be delivered not later than Saturday, the 11th February next.

Electric Exhibition in Glasgow.—In connection with Messrs. Mavor and Coulson's electrical works in George-square, Glasgow, a public exhibition, illustrating the development which is taking place in electrical appliances, has been opened. The development referred to is in the direction of heating, and for application to light culinary operations. Contrivances are shown by which heat can be obtained for the almost instantaneous boiling of water, for the preparation of tailors' irons, for warming offices or rooms, and for other purposes; and the exhibition has been found very interesting.

Yarmouth.—At the meeting of the Yarmouth Town Council last week a motion by Mr. Peaton was down to be moved: "That in deference to the resolution adopted at the town meeting, held on December 21, as well as the general feeling of the burgesses, the Council rescinds the vote of December 13, in favour of immediate action in respect of the electric lighting scheme, and instructs the committee to reconsider the subject." A copy of the resolution adopted at the recent public meeting on the subject was read. As the meeting had sat late, this matter was adjourned till the next meeting.

Edinburgh.—The deputation of the Edinburgh Town Council who lately visited several towns in England with the view of gaining information as to the system of electric lighting in vogue there, had a meeting last week, when further consideration was given to the report which the deputation is to make to the Council. The terms of the report were, so far, adjusted, and it was agreed that the document should be printed, and thereafter come before the deputation for final approval. The publication is awaited with interest, as the lighting of the capital of the North will be dependent upon the effect of this report.

Transvaal.—At the second meeting of the Champ d'Or French Gold Mining Company, of Transvaal, the chairman, M. E. Montfort, said that in September they had introduced electric transmission of power for the first time, and the plant has been running since without stopping night and day. They have two dynamos driven from the mill countershafting, connected by overhead wires to the motors at the pumps. A switch allows the motors and pumps to be controlled from the mills. Previously the pumps had been driven by wire rope, which was always giving trouble, and the saving to the company is estimated at £4,000 a year.

Southend.—At the Southend Town Council meeting last week it was agreed that an additional engine boiler and dynamo be purchased for the pier at an approximate cost of £870. A recommendation that five additional tramcars be purchased, at an approximate cost of £1,190, was lost by one vote. Alderman Hemmann thought they ought to have electric lighting in the town. They had a provisional order obtained at great expense, and if they did not take care it would be running out before it was used. He considered it right that the Council should consider the whole question. The reference for application for powers to borrow money for the additional plant was carried by a large majority.

Paddington Electric Railway.—General Webber writes to the *Standard* of the 16th with reference to the Clapham Junction and Paddington Railway, that it is not a fact that the proposed subway would be at any point nearer than 50ft. to the surface. No borings or ventilators would be necessary in Kensington-gardens, air-holes being, indeed, contrary to the principle of air circulation adopted. The advantages of affording transit from Paddington to Clapham Junction in 20 minutes are obvious. The subway is not necessarily to benefit the Albert Hall, for the railway would not take persons there unless they wished to go there. The promoters ask fair treatment, and are content to abide the issue in Parliament.

Sydney.—Arrangements are in progress for lighting the Sydney Post Office clock by electricity. A temporary agreement has been entered into with the Electrical Material Company, whose plant is close by, for the supply of electricity to the clock tower and lamps near. This company had the contract for lighting the Theatre Royal by electricity before it was burnt down. The cables will be brought under Pitt-street through a new tunnel, which has just been completed. There are six ornamental public lamps, with five lights on each lamp. The clock will be lighted by incandescent lamps from the inside by means of 16 lamps for each face. An engine and boiler room are to be provided at the post office shortly, and the clock will then be lighted by the Department.

Hull.—The Corporation supply of electric light in Hull was inaugurated on Monday. At first the area of supply will be limited to the old town within the docks. For this purpose an installation has been erected on the dock side, and the mains have been laid along Whitefriar-gate and adjoining streets. The plant already fixed includes three boilers, four engines of 560 aggregate horse-power, which drive four dynamos capable of supplying 4,700 16 c.p. lamps simultaneously. Arrangements are also being made for accumulators sufficient to allow the engines to remain inactive during the night. The station was opened with ceremony by the mayor, and a public exhibition of electric light appliances and plant is held until Saturday. The boilers are by Davey, Paxman, and Co , and the dynamo by Siemens Bros.

London Electric.—The prospects of the London Electric Supply Company are brightening in an encouraging manner. They have now lamps equal to 52,000 lamps, 8 c.p., connected or waiting to be connected, and the increase in number is steady. Mr. H. F. Lewis is busy organising the outside business department with encouraging success. This Company came out very well on the occasion of the late great fog, and the constancy of the supply never faltered, as testimonials from the customers and special recording tests proved, while the pressure of some of the other companies went down at times considerably. No trouble has been found with the underground mains, and the machinery is working excellently. It is to be hoped the Company will achieve their full complement of 90,000 lamps before the end of the year.

Electricity on the Thames.—A large steam launch is now being laid down at the Thames Electric and Steam Launch Company's Works at Eel Pie Island, Twickenham, to the order of Henry Astrop, Esq., of Kingston. Besides the launch engine of 85 h.p., there will also be an electric light installation fitted on board. The dynamo will be coupled on direct with the engine on one bed-plate, and the various rooms illuminated by incandescent lamps. The dynamo will be shunt wound for charging accumulators for a small electric pinnace. This vessel is to be used for navigating the Thames and canals in France, Belgium, and Holland, and is luxuriously fitted. There will shortly be a number of electric launches fully equipped ready for the coming season, including two electrical sailing gigs, designed by Mr. Sargeant for sailing, rowing, or to be propelled electrically.

Dover.—The mayor, aldermen, and burgesses of the borough of Dover, the undertakers for the purposes of the Dover Electric Lighting Order, 1890, give notice that, with the consent of the Board of Trade, they propose by deed to be approved by Board of Trade to transfer their powers, duties, liabilities, and works to a company to be registered under the Companies' Acts, 1862, to 1890, entitled the Dover Electric Supply Company, Limited. On the sale of the undertaking to the Corporation at 21 years and subsequent periods of 10 years from the transfer the Corporation are to pay the value and the goodwill thereof as a going concern with an allowance of £10 per cent. for compulsory purchase, and in case of difference the value is to be determined by arbitration. After 42 years the Corporation is to pay the then value in accordance with the Electric Lighting Act, 1888.

Taunton.—At the monthly meeting of the Taunton Town Council, held last week, the Electric Light Committee reported that the Board of Trade had granted a license for the supply of the electric light by the Council. The committee had considered the amount which would be required under the provisional order for which it had been decided to apply, and had made various additions to the items contained in the estimate for £14,000, raising that sum to £16,000. These items were: additional alternator, £400; extra boiler and fitting, £450; carrying out transverse steam-drum system, £350; belts and foundations, £49; 20 additional meters, £200; additional legal expenses, £150; sundries, £401. The committee recommended that an application should be made in due course to the Local Government Board for leave to borrow this amount, repayable by equal instalments in 30 years. This report was adopted, Alderman Standfast voting against it.

Anglo-American Telegraph Company.—At a meeting of the Board of Directors of the Anglo-American Telegraph Company, Limited, held last Friday, it was resolved to recommend to the proprietors at the next half-yearly general meeting of the Company, to be held on January 27 next, the declaration of the following dividends: 1. A balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ended December 31, 1892. 2. A balance dividend of £1. 15s. per cent. upon the preferred stock for the year ended December 31, 1892, both payable on January 28 next, less income tax, to the stockholders registered on the books of the Company on the 10th inst. After paying the foregoing dividends there will be a balance of about £737 to be carried forward to the next account The above dividends, together with those already paid, will amount to £2. 15s. per cent. on the ordinary consolidated stock and £5. 10s. per cent. on the preferred stock for the year 1892. The register of transfers will be closed from January 13 to January 27, both days inclusive.

Heckmondwike.—At the meeting of the Heckmondwike Local Board on Monday, Mr. S. Wood's motion to engage Mr. Hutchinson, C.E., to prepare needful plans and specifications for conducting the Board's proposed electric lighting scheme before a

Local Government Board enquiry, was negatived by five votes to four; and it was resolved, on the motion of Mr. Thomas Redfearn, seconded by Mr. J. E. Crabtree, to disbandon the Electric Lighting Committee of the Board, transferring the duties of that committee to the General Works Committee. Mr. S. Wood took this in the light of a no confidence vote; and Mr. A. Rhodes, who concurred, observed that it was no use having a committee whose recommendations, though unanimously made, were rejected by the Board. It was subsequently resolved, on the proposition of Mr. Wood, to advertise for an electrical engineer to carry out a scheme of lighting for the Board, the mover expressing his belief that Mr. Hutchinson's scheme would not only be approved of when another engineer was called in, but would be commended. At a later stage of the meeting, Mr. Redfearn complained of the bad quality of the gas at present supplied, and enquired what means the Board possessed of testing the gas. The clerk gave the required answer, and the matter was left over, Mr. Wood observing that the Board would arrive at the best and quickest solution of the difficulty by adopting an installation of the electric light with all possible speed.

Boilers at Melbourne General Post Office.—The gradual extension of the electric lighting installation at the Melbourne General Post Office, and the contemplated introduction of the pneumatic delivery of messages throughout the principal parts of the city have rendered the introduction of additional boiler power necessary, and instead of supplementing the original plant, it was decided to provide new and approved boilers. The plans were prepared and submitted by Mr. A. Wilson, engineer in charge of ports and harbours, Victoria. The specification stated that the boilers were to be constructed in accordance with the Board of Trade rules for a working pressure of 100lb. to the square inch The shells were formed in each case of nine plates in three strakes, the branches connecting shells and domes are steel castings, while the furnaces are of Foxe's best corrugated steel. The stays and all forgings are of best Lowmoor iron; all tubes are solid drawn steel of Lloyd and Lloyd's make, and are ⅛in. in thickness. Six cast-iron brackets form the seating for each boiler, and are so arranged as to leave every part easily accessible for repairs or inspection. Smokeboxes and down-takes are of iron. Before delivery each boiler had to remain tight under a cold-water pressure of 200lb. per square inch. The successful tenderers were Messrs. Foreman and Co., of Melbourne, the contract price being £2,872. The construction was carried out under the supervision of Mr. C. N. McLean, engineer surveyor to the Marine Board, and all three had to be finally passed by him after erection at the post office.

Coventry.—At the meeting of the Coventry City Council on Tuesday, the consideration of the General Works Committee's report on the question of electric traction for the Coventry and district tramways, which had been adjourned from the meeting a month ago, was resumed. The system proposed by Mr. W. S. Graff Baker, the owner of the tramways, is that known as the Thomson-Houston overhead-wire system, and a short sample of the wiring has been erected in Hertford-street. The Mayor moved the adoption of the report, which recommended the Corporation "not to consent to such a system in Coventry under any circumstances whatever," and argued that they should adopt a waiting policy, as he believed that before long a better system would be introduced. Alderman Marriott seconded the motion. Mr. West moved an amendment, that permission be granted for the completion of the wiring through the city, provided an equitable agreement could be executed as between Mr. Baker and the Corporation, and that poles only be erected where permission could not be obtained to attach the wire to the adjoining property; and to that end that the report of the General Works Committee be referred back, with instructions to report as early as possible. Mr. Horton seconded the amendment Alderman Maycock, having seen the system in America, said the sample put up in Coventry gave no idea of the ugliness and unsightliness of the network of overhead wires. After a prolonged discussion the amendment was carried by 20 to 14, with the omission of the clause relating to the erection of poles where arrangements for attaching the wires to property could not be made.

Pembroke.—A meeting of the Pembroke Commissioners was held on Monday in the Town Hall, Ballsbridge, Sir Robert Jackson, C.B., chairman, presiding. There were also present William Beckett, George W. Casson, J.P., John J. Cranny, M.D., Colonel Andrew Vesey Davoren, J.P., John Gibbs, J.P., Frederick Morley, C.E., Surgeon Lieutenant-Colonel Nash, J.P.; James H. Shegog, Fane Vernon, J.P., George Walker, and George J. Wells. The meeting was made special for the consideration of the alterations in the Southern District line, for which a provisional order from the Privy Council is being sought, and also the proposed Bill to be promoted in Parliament for working the line by electricity. Mr. Clay, solicitor to the tramway company, attended and gave particulars of the proposed introduction of electricity as a motor for the tramways. The current would be harmless. In the United States there were no less than 4,000 cars, running over a distance of 3,000 miles. The tramway company intended to have a 10-minute service of cars and reduce their fares. By increasing their generators, arrangements could be made to light the township with electricity at a lower cost than if the Commissioners started a system for themselves. He believed the system would be working in six months' time. On the motion of Mr. Vernon, seconded by Colonel Davoren, it was resolved that the Board, as the local authority, consented to the introduction of electricity, subject to an undertaking by Mr. Clay on behalf of the company, that a clause should be introduced giving the township engineer power to direct where the posts should be placed, and to have them shifted if necessary, and also that they might be used free of cost for lamps if the Commissioners thought fit to light the township with electricity.

Society of Arts.—A special course of six lectures, under the Howard Bequest, is being delivered on Friday evenings, at eight o'clock, by Prof. W. Cawthorne Unwin, F.R.S., on "The Development and Transmission of Power from Central Stations." Lecture I.—January 13: Commercially Available Sources of Mechanical Energy—Conditions in which Development at Central Stations and Distribution is Demanded—Steam Power Fuel Consumption—Cost—Influence of Variability of Load on Choice of Steam Machinery—Cases in which Internal Furnace Engines have an Advantage—Storage of Power—Battery Storage—Thermal Storage. Lecture II.—January 20: Water Power—Increase of Availability of Water Power if Transmission is Possible—Types of Water Motors—Governing of Hydraulic Motors—Cost of Water Power—Storage of Power by Reservoirs and Accumulators—Systems at Zürich and Geneva. Lecture III.—January 27: Methods of Distributing Energy—Distribution by Shafting—Tele-dynamic Transmission—Installation at Schaffhausen, Bellegarde, and Gokak—Practical Defects of the System. Lecture IV.—February 3: Hydraulic Distribution of Power—History of Hydraulic Transmission—Combination of Water and Power Supply—Conditions of Efficiency—Limitations—London System—Motors for Hydraulic Systems. Lecture V.—February 10: Transmission of Power by Compressed Air—History of the Paris Scheme—Action of Compressor Main and Motor—Reasons of Low Efficiency—The New Paris Station—Advantages of Compressed Air—Applicability to Long-Distance Transmission—Distribution of Power by Gas, by Steam, and by Superheated Water Lecture VI.—February 17: Distribution of Mechanical Energy by Electricity—Systems Hitherto Adopted—Examples of Distribution of Motive Power Electrically—Hersthal Installation—Niagara Scheme—Advantages of Combined Schemes—Heat and Power—Light and Power—Water Supply, Light, and Power.

Newbury.—At the meeting of the Newbury Corporation on the 10th inst., Mr. Lucas explained with regard to the application from Messrs. Woodhouse and Rawson, that some time in the summer a suggestion was made about the electric lighting order, and he was asked whether it was for sale. He then said if they could get a purchaser they were disposed to got rid of it. Being in London, he called upon Messrs. Woodhouse and Rawson, who said they would be prepared to buy if the Board would sell the order. In December he received a letter from them asking if they would sell the electric lighting order and the gas undertaking, and he was instructed to reply, asking them if they would purchase the order alone. They answered that they were afraid they could not purchase the order separately, as in their opinion it would simply mean conflicting interest between the owners of the electric lighting and the Corporation, as owners of the gasworks. Personally, he hardly knew what to say about the matter. If the Corporation had no wish to sell the undertaking, the matter might be allowed to drop; if they thought it desirable to negotiate, then that would be a matter for a committee of practical men, to arrange terms and other matters. Mr. Ravenor said the fullest publicity should be given to the matter, and so enabling other people to come forward and say they would purchase the order. If allowed to be kept quietly, the time would expire and the order would be worth nothing. Mr. Midwinter moved, "That the Gas Committee be requested to consider the application of Messrs. Woodhouse and Rawson, and report to a special meeting of the Council." Mr. Long seconded. Alderman Adey could not see the use of referring the matter to a committee seeing that they would not sanction the disposal of the works. Mr. Lucas said it was a difficult question, as no one knew how the electric light would eventually affect the gas undertaking. They would have to face this, for the Corporation or someone else would have to carry out this order. There ought to be no conflicting interests in the matter; either they should do it themselves or somebody else should do it. Whoever had the electric lighting order should have the control of the public lighting. The amendment was put and carried.

Bradford.—Alderman F. Priestman, at the Bradford Town Council meeting last week, moved a resolution enlarging the area for electric lighting, to include certain other streets. Alderman Priestman said that the streets named formed an extension of the present area of supply, and the whole of the area, including the additions, could, if necessary, be lighted from the present station. The extension of a few of the mains was necessary, and other streets had been included as a matter of convenience. The resolution having been seconded, Mr. L. Walker said that as soon as these streets had been passed, Alderman Priestman would be wanting an extension of the plant. That had always been the case. There was no finality about this matter. Alderman J. L. Morley said that the property of Messrs. Rand would be in possession of the Corporation within the next four or five months, and Manchester-road, which was included in the present list of streets, could be worked more economically, and that portion of the town generally could be worked more economically from that spot than from Canal-road. Mr. M. O'Flynn hoped that when the cables were laid down in these new streets they would be made sufficiently large to obviate the tearing up of the streets a few months afterwards in order that larger cables might be laid. Alderman F. Priestman quite agreed with Mr. L. Walker that there was no finality about this question. Having furnished the centre of the town with the electric light, its extension further afield would continue as long as the undertaking yielded a profit. He hoped to come before the Council for the extension of the plant in the existing buildings, and he believed that would have to be done before the next summer was over. He did not think it was worth while to take exception to any particular street in the proposed list, because the adoption of these streets did not necessitate that the cables should be put down. The only reason why culverts were not laid down in the first instance was the enormous expense, and the impossibility, in consequence, of making the electric light pay. Now that the initial work was over, and the electric-light system was beginning to pay, the expense would not weigh with the committee so much as the public convenience. and he was sure that the point mentioned by Mr. O'Flynn would be borne in mind. The resolution was adopted.

Barnet.—The never-ending question of electric lighting at Barnet came up last week before the newly-formed Barnet Ratepayers' Association meeting. Mr. Sidney Morse presided. It seemed to him desirable to consider whether it was necessary for the Local Board to spend £300 on a provisional order. No one else was making an application, but the Board were still proceeding. The Board, as lighting authority, had power to light by electricity if they desired. There could only be one object in the application—to empower the Board to supply private persons. It did not seem reasonable that the ratepayers should be called upon to pay until they had been consulted and expressed approval. No private person could get a provisional order without consent of the Local Board. Personally, he was sorry the Board had refused Mr Joel's application, because then they would have had someone spending money for the benefit of Barnet. He could not understand objection to anyone spending money for the benefit of the town, and he was therefore astonished at the position which the Local Board adopted. In the event of anyone desiring to object to the provisional order, notice must be given to the Board of Trade on or before the 14th or 15th inst. Assuming that the association sent in a notice of objection, the Board of Trade would very likely direct a local enquiry to be held before deciding whether the order should proceed or not. Mr. Rogers said that something must be done, and very quickly too, unless the ratepayers were prepared to pay. He felt that the council should be authorised to take the question of the electric light in hand at once. If the provisional order were granted the Local Board would be in a position to go to work immediately, and that meant incurring a liability to the town to something like £12,000; and the ratepayers, having elected the Local Board, must meekly submit to pay for the experiment. To oppose the grant of the order might mean some expense, but there were gentlemen connected with the association who would at the enquiry give the members the benefit of their legal knowledge. No doubt the association would be able to protect its interests at the enquiry without any great cost. Mr. Charles said the Local Board had no right to enter upon a gigantic enterprise of this sort without consulting the ratepayers. If the association thought the action of the Board should be opposed, he would write to the Board of Trade, and his humble services were gratuitously at the disposal of the association in the event of an enquiry. The Local Board was obtaining the provisional order for the purpose of keeping out that much-abused man, Joel, but why should they object if Mr. Joel liked to spend his capital here? Mr. Joel, however, could not get an order without the consent of the Local Board. It was unwritten law that if the Board withheld its consent a provisional order could not be granted. Then what was the aim of the Board? The Local Board held the whip hand, and if it objected to anyone coming here with the electric light the course was simple and plain. All the Local Board had to do was to impose conditions, and, if they were accepted, incorporate them. It was finally resolved to authorise the council to take the necesssary steps to object to the granting of the provisional order, and that a public meeting should be held at an early date to consider the action of the Local Board.

PROVISIONAL PATENTS, 1893.

JANUARY 9.

402. **An improved automatic cut out for series incandescent electric lighting.** Arthur Percy Donnison and Matthew Henry Barber, 4, St. Ann's-square, Manchester.

442. **New electric lighting of gas-engines.** T. Carlo, Genoa.

449. **Improvements in or relating to electric motors.** Imle E. Storey, 70, Chancery-lane, London. (Date applied for under Patents Act 1883, sec. 103, June 9th, 1892, being date of application in United States.)

457. **Improvements relating to the coating of wire and other rolled or drawn metallic sections by electro-deposition, and apparatus therefor.** Sherard Osborn Cowper-Coles and the Metallurgical Company, Limited, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 10.

471. **Improvements in variable-speed electric motors.** Charles Arthur Allison, 52, Chancery-lane, London. (Carl Hering, United States.) (Complete specification.)

510. **Improvements in electric transmission of power.** Ernest de Pass, 78, Fleet-street, London. (Edwin Wilbur Rice, jun., United States.) (Complete specification.)

516. **Improvements in measuring and recording instruments for electric currents.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Weston, United States.) (Complete specification.)

517. **Improvements in instruments for measuring electric currents.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Weston, United States.) (Complete specification.)

518 **Improvements in apparatus for measuring electric currents.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Weston, United States.) (Complete specification.)

519. **Improvements in electric resistance-boxes or coils.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Weston, United States.) (Complete specification.)

520. **Improvements in and relating to apparatus for measuring and indicating electric currents.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Weston, United States.) (Complete specification)

538. **Electromagnetically-heated receptacles and articles.** Willis Mitchell, 77, Colmore-row, Birmingham. (Complete specification.)

562. **Improvements in electric measuring instruments.** Walter Thomas Goolden and Sydney Evershed, 1, Queen Victoria-street, London.

JANUARY 11.

583. **Improvements in self-recording electric apparatus.** Arthur Wright, 26, Park-crescent, Brighton.

601. **Improvements in and relating to the manufacture of electric incandescent lamps.** John Robert Hughes, 10, Bartholomew-close, London.

605. **Improvements in and relating to the measuring of electricity, and in meters therefor.** Rankin Kennedy, 96, Buchanan-street, Glasgow.

628. **Improvements in brackets, standards, and other electric light fittings.** Harold Faraday, 11, Southampton-buildings, Chancery lane, London.

660. **An improved method of manufacture of elements or plates for secondary batteries.** Hugh Fitzalis Kirkpatrick-Picard and Henry Thame, 1, Queen Victoria-street, London.

JANUARY 12.

694. **Airtight electric lighting wire casings.** Robert Atkinson, 29, Wycliffe-road, Shipley, Yorks.

724. **Improvements in filaments for incandescent electric lamps.** Frederick Roberts Pope, 76, Chancery-lane, London. (Complete specification.)

736. **Improvements in the manufacture of white lead and other compounds electrolytically, and apparatus therefor.** James Charles Richardson, 6, Bream's-buildings, Chancery lane, London.

JANUARY 13.

757. **Improvements in platinised electrodes.** Harry Theodore Barnett, 14, Narcissus-road, London.

758. **Improvements in connection with carbon electrodes.** Harry Theodore Barnett, 14, Narcissus-road, London.

775. **Improvements in electric arc lamps.** Eugene Conrady, 56, Low-street, Keighley.

791. **Improvements in devices for opening and closing electrical circuits.** John Henry Tucker, 65, Witton-road, Aston, Birmingham.

813. **Improvements in or connected with the manufacture of electrodes for electric accumulators.** Charles Pollak, 33, Chancery-lane, London.

814. **Improvements in dynamo or motor brushes or collectors.** Frederick Henry Judson and William John Woodward, 19, Ewer-street, Southwark, London.

JANUARY 14.

841. **Improvements in the electric illumination of clocks.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

869. **Improvements in electric belts** Henry Nehmer, 4, Grafton-street, Gower-street, London.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5	5½
	3	3¾
London Electric Supply	5	¾
Metropolitan Electric Supply	—	7
National Telephone	5	4¾
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	6

NOTES.

Electro-Harmonic.—To-night the Electro-Harmonic Society will hold their smoking concert.

Stockport.—A deputation from Stockport has visited the electric light installation at St. Helens, with a view to adopting similar measures.

Belt Mounter.—An ingenious combination of ropes and sliders for mounting belts on overhead pulleys is shown in the *Revue Industrielle* for 21st inst.

Dahomey.—The French Government have given the order for the establishment of a telegraphic service to Dahomey. The line from Kotonoo to Popos has been commenced.

Amount of Water in Steam.—Before the North-East Coast Institution of Engineers at Newcastle, on the 30th inst., Mr. W. R. Cummins will read a paper on "An Apparatus for Determining the Amount of Water suspended in Steam."

Hull Exhibition.—The exhibition of electrical appliances has proved very popular at Hull, the rooms being overcrowded. A charge of threepence each was made during the latter days—the amount obtained to be applied to the distress in the town.

Old Swindon.—The Local Board is about to consider the question of inviting tenders for lighting the district of the Old Swindon Local Board with the electric light from January 1, 1894, for seven years, the Board to have the option of purchase at the end of that time.

Howard Lectures.—The fourth Howard lecture by Prof. Unwin at the Society of Arts on "The Development and Transmission of Power from Central Stations," will be given to-night. The lecture deals with the hydraulic distribution and motors for hydraulic system.

Polyphase Motors.—Mr. Charles Bradley's method of wiring buildings for lamps and motors on the polyphase-current system is given in abstract in the New York *Electrical Review* for January 14. One transformer can be used on this system for both lighting and running motors.

Books Received.—We have to acknowledge the receipt of "The Theory and Practice of Absolute Measurements in Electricity and Magnetism," by Andrew Gray, M.A., professor of physics in the University College of North Wales, in two volumes, price 25s. Macmillan and Co.

Electric Heater.—After numerous experiments, say MM. Henriot and Lebrasseur, of Havre, they have invented a serviceable electric heater, consisting of metal wires embedded in refractory earthenware. There seems little novelty about this, for electric heaters on the Carpenter system are now common.

Lecture.—Mr. T. S. Watney, of Leeds, delivered a lecture on "Electric Lighting," on Monday, before the Leeds and Yorkshire Architectural Society. Dynamos, lamps, and switches were explained, and the best method of wiring buildings was described. The forms of fittings and the cost of light were also touched upon.

"Universal (Berly's) Electrical Directory."—The twelfth annual publication of this electrical trades' directory will shortly issue from the press. The editor earnestly requests that all persons and firms who have not as yet sent in their particulars for the 1893 book will do so at once, addressed to the editor, care of H. Alabaster, Gatehouse, and Co., 22, Paternoster-row, London, E.C.

Electric Launches at Southport.—Lord Coleridge and Mr. Justice Charles, on Wednesday, quashed the conviction against the Southport Corporation for having an electric launch on the Southport foreshore lake for the conveyance of passengers without a certificate under the Merchant Shipping Act, 1854. Their lordships said it was absurd to think that a small electric boat on an artificial piece of water was ever intended to come within the Act.

Noiseless Gas-Engine.—A simple method of making the discharge from gas-engine exhausts is described by M. P. Simon, who has made many experiments to this end. A pipe is split for 6ft. by a saw-cut, and the slot spread out till at the top it has a width of the diameter of the pipe. The discharge of burnt gas spreads out like a fan upwards, and takes place gradually without noise. This will be very much simpler than the silencing chamber.

The British Museum Reading-room.—The following letter, written from the Athenæum Club, appeared in the *Times* last Friday: "It surely is time that steps were taken to light the British Museum reading-room more efficiently than at present. An hour seldom passes without one or other of the lamps going out, and so plunging many students into semi-darkness; while the loud and continuous hissing made by all of them is a serious interruption to steady work."

Electric Ship Lights.—A memorandum having been received by the Admiralty from the Board of Trade stating that the tint of green in ships' sidelights is affected when the lamps are lighted by electricity, the Commander-in-Chief at Portsmouth has ordered that, with a view of ascertaining whether the tint of green used in the naval service is suitable for navigating purposes, a report is to be forwarded through him to the Admiralty from each ship fitted with electric bow lanterns.

Zurich Central Station.—To electrical engineers who can read German, the Austrian technical journal, *Zeitschrift für Elektrotechnik*, of January 15 will be interesting, as it contains a very full description of the Zurich central station, with photographic reproductions, full ground plan of the turbine and dynamo arrangements, and a diagram of the connections of conductors. The arrangements for testing, connections of exciters and alternators, automatic regulators, voltmeters, and compensators, are clearly shown on a large sheet of diagrams.

Lectures to Electrical Men.—The secretary of the Electrical Trades' Union, Mr. A. J. Walker, is trying to arrange a series of free lectures by recognised authorities to members of the association, open also to the electrical profession generally, dealing with practical subjects connected with technical work. The course will be arranged for next winter session, 1893-4. Similar monthly lectures have already been held with very satisfactory results in Glasgow, the first lecture having been given under the presidency of Lord Kelvin.

Electrical Maps.—In issuing a map of electrical progress, if published in advocacy of any single company's progress, there is one easy method of convincing the unlearned of the great advance of this same company—namely, by leaving out many of the rival's mains and printing what are shown in a very light yellow, while "the" company's own mains are shown (both those laid and intended) in a very vivid red. Have we ever seen such a map as this, and issued by a technical journal? Oh! dear, no; not until the last few weeks, at any rate.

Electrolytic Aluminium.—It is possible by means of the electric current to decompose chlorides into chlorine and the metals. Bunsen thus obtained magnesium, and later, with Mathiessen, barium, strontium, calcium, by passing a suitable current through melted chlorides. H. Sainte-Claire Deville, says the *Bulletin Internationale*, has applied this method with the greatest success to the preparation of aluminium, the details of the process being described. While speaking of this, it would be interesting to learn whether there is any truth in the report that an experimentalist in Berlin has perfected a method for producing aluminium at 2d. a pound.

Electric Gatling Gun.—A Dalziel's correspondent says that it is reported that Dr. Gatling is attracting the attention of the American naval and military authorities by his researches in electricity, which have culminated in his inventing a method by which electricity can be applied to firearms. He claims that his new gun will be superior to existing Gatling guns and mitrailleuses, or any other machine guns, and will fire 2,000 shots a minute. The power is derived from an electric motor, which is attached by a belt to the mechanism of the gun. The cost of firing will be reduced to a minimum. The invention will shortly be tested by the Board of Ordnance officers.

Cold Engines.—The investigations of Prof. Dewar, described elsewhere, indicate the beginnings of what may eventually develop into an extremely important industry. Combinations of chemicals of one kind produce heat, and of another kind produce cold. The available energy for motor purposes in expanding gases is that owing to the extreme differences of absolute temperature. Energy can be as certainly drawn from the heat of the surrounding air by a cold-engine, as it can be developed by a heat-engine. It is possible that efficient motors should be developed to utilise the extreme below as well as the extreme above the air temperature, when the way to do so economically has been shown.

Simple Heat-Engine.—An ingenious motor to utilise heat-rays of the sun, gas, or coal direct without intervening mechanism of transformation, is shown in the *English Mechanic* for last week. A large corrugated drum is filled with some expansible liquid or gas; inside are vanes which are moved by any rotation of this liquid or gas, driving a pulley. On putting this simple piece of apparatus near a fire, or in the sun, where one side only of the drum is heated, or by applying a gas-jet, varied expansion is caused inside the drum, and the pulley rotates forcibly. This is said to be the first motor to obtain useful rotary mechanical energy direct from the sun. It can be applied to drive a miniature dynamo.

Municipal Stations.—The report of the Edinburgh deputation on electric lighting contains an interesting and important expression of opinion on the part of municipal authorities. The deputation state that from conversation with certain authorities they learned that experience had shown that electric lighting is not likely to prove profitable until the second or third year, as many consumers only apply after they have seen the light used by more enterprising neighbours, but in the various places visited the deputation found that the demand for electricity was increasing. They were very strongly advised by the authorities with whom they came in contact to work the electric lighting order themselves, and not to hand it over to a company.

Laminated Cores.—Mr. Thos. D. Lockwood, in the New York *Electrical Engineer* for the 11th inst., recounts the part that Prof. Chas. Grafton Page took in the discovery of the efficacy of laminated magnet cores. Though employed in the Patent Office, he obtained a patent by special Act of Congress in 1868, reissued in 1871, and sustained in 1879. From a consideration of the records, says Mr. Lockwood, it appears that Sturgeon was first in the idea of dividing the iron of cores, and first also in publication; that Bachhoffner was a close second both in performance and publication, and also the first to observe the utility of insulating the wires; and that Page was third in performance and publication, second in noticing the importance of insulation, and first in his reasonings upon the subject, and independent and original in every point.

Alternate-Current Meter.—Mr. S. D. Mott, in the *Electrical World* for the 14th inst., describes an electric meter on a new principle, which he has devised for alternate currents. It depends on the repulsion and consequent rotation of metallic points, as in the well-known electric flyer. A small transformer transforms the current to a very high potential, which is led to needle points, which are placed so as to revolve. The breeze from these points is sufficient to blow out a candle, and the speed of rotation proportional to the static charge, and the static charge to the current passing. This static meter for high potential currents is geared to dials in the usual way; but the meter seems to be a suggestion, and not the description of a practical apparatus. The author says, "it will be observed that for economy of operation and cheapness of construction the meter is all that could be desired."

Cobalt-Plating.—The cobalt which would be required for plating on the method to which we recently alluded, is now bought up in bulk by two or three chemical manufacturers, and is almost entirely used at present for blue colouring of glass and pottery and blue glaze. Its cost in reality is not more than that of nickel, but it is retailed at something five times this cost. If cobalt-plating, as suggested by Dr. Silvanus Thompson, were to come in, cobalt being used more largely would soon become as cheap as nickel. The process was patented, but the patent has now dropped through, and is therefore open to the world. The chief ingredient of the most practical process is Epsom salts, through which the silvery metal is deposited. The polishing is done in the usual way with scratch brushes, and the resultant white coating is almost indestructible by damp or smoky air. For town or seaside ornaments and fittings, and especially for ship fittings, in place of nickel the cobalt-plating should be invaluable.

Telegraphy Illustrated.—A handsome volume of 190 pages, printed most neatly in red and black, filled with delicate woodcuts of all kinds of telegraphic and telephonic apparatus—such is the "Catalogue Illustré" of the Société Général des Téléphones. The book is printed by the Parisian Imprimerie Chaix, and is published by them at 2, rue Bergère or by the Société des Téléphones, 41, rue Caumartin, and their London agency, 29, Ludgate-hill. It will be impossible for us to enumerate the large range of apparatus dealt with—keys, galvanometers, plugs, and switches. The woodcuts have a peculiar artistic excellence of shading, obtained by clever manipulation by the illustrator, Sauvert, of Paris, of fine lines in close juxtaposition and lines of dots. Relays, railway signals, Morse instruments, duplex telegraphic sets, are shown with photographic accuracy. An important department is that of fire-alarms. The system of telephonic alarms patented by M. Digeon is graphically illustrated at work.

Desrozier Dynamo.—The *Revue Industrielle* gives, in its issue for January 21, a description, with illustrations, of the Desrozier dynamo direct coupled with a gas-engine. This dynamo combines the necessary qualities of a good dynamo under excellent conditions—high speed of armature, strong field, lightness of armature, regularity, and ease of winding. There is no iron in the armature, and a linear speed of 20 to 25 metres per second can be obtained without raising the speed of rotation very high. The dynamos are made at 350 or 150, and even down to 70 revolutions a minute. Coupled to a 6-h.p. gas-engine at 250 revolutions the dynamo produces 3,400 watts at 70 volts, lighting 28 16-c.p. lamps, one 32-c.p. and one 7-ampere arc lamp. Larger machines are being built up to 120 h.p., with gazogenes, and the consumption, guaranteed not to exceed 500 grammes of coal per actual horse-power hour, in practice is said not to exceed 465 grammes. Central stations with gas-engine coupled direct working at this figure would certainly seem to commend themselves, as advocated in this country by Mr. Thwaite.

Church-Lighting.—St. Peter's, Hatton-garden, will, the *Pall Mall Gazette* says, have the honour of being the first Catholic church in London to be illuminated by the electric light. The order for the installation has been given. It has been found that the valuable frescoes with which the interior is decorated have been injured by the use of gas. From its dingy and uninviting exterior no one would imagine that internally this church is one of the most artistically decorated in London. The "Italian Church," as it is commonly called, was built 30 years ago with moneys collected all over Europe, but chiefly in Italy. The scheme of decoration, however, has only been recently completed. The clergy attached to it are decidedly cosmopolitan. The languages they speak comprise English, French, German, Italian, Spanish, Polish, Croatian, and Lithuanian. The Italian church is now one of the few Catholic places of worship that employ professional vocalists and instrumentalists from the London theatres for the rendering of their musical services. The stern and ascetic Manning very nearly suppressed that sort of thing.

Government and the Telephones.—The London Press Exchange learns that the work of constructing the new trunk line of telegraph wires from London to the Midlands and North, authorised by the Telegraph Act of last year, has been far advanced by the Post Office, and it is expected that before long Glasgow and the large towns south of it will be in telephonic communication with London. It is in contemplation to extend the trunk-line system from Glasgow to Stranraer, whence a new cable is to be laid to the Antrim coast, and placed in connection with a new trunk line to Dublin. By this means it is hoped that both Belfast and Dublin will be placed within speaking distance of London. The new cable is already being made, and will be laid in the summer. The existing cables between Carnarvonshire and Wicklow are too long to admit of communication being made telephonically between the two capitals, the resistance being so great. The existing trunk lines of the National Telephone Company from London to Birmingham, Manchester, and Liverpool have not yet been taken over by the Government, but the negotiations in that direction are proceeding.

Radiation through Vacua.—The experiments of Prof. Dewar upon the effect of high vacua on the radiation of heat, undertaken in the course of his researches with liquid oxygen, lead to some interesting considerations that may cause us to modify entirely our conception of radiation of the sun's heat. It has been usually taken that the long heat-waves, as well as the short light-waves, came direct by radiation from the sun, and that consequently an enormous amount of energy was continually being dissipated. But Prof. Dewar's experiment tends to show that an absolute vacuum is entirely impervious to low waves of heat radiation. Interstellar space, therefore, though transparent to light radiation, does not presumably convey heat radiation at all, and the heat-waves manifest in the atmosphere are created there. We see in this the necessity for remodelling our theories upon the time required to cool the earth down, for if space is impervious to heat radiation—as is Prof. Dewar's vacuum—we need not fear cooling on this account. The interstellar space has lost one of its properties, and at a stroke, by a simple experiment, a huge proportion of the supposed available energy of the solar system disappears.

Temperature of the Arc.—The determination of the exact temperature of the arc is a difficult operation, and for arcs taking heavy currents even a dangerous one to the face and eyes. M. Violle has carried out a series of careful observations of this nature, however, with arcs taking 500 up to 34,000 watts, and finds the temperature is identical for all arcs. This point will be the volatilisation of the carbon. To measure this temperature a slit was formed on the positive carbon at ⅜in. distance from the end, and when the passage of the current had caused this terminal knob to attain its highest brilliancy it was knocked off into a calorimeter ready prepared, so that there should be the least possible loss of heat. The temperature thus measured was found to be 3,500deg. C., which is therefore that of the volatilisation of carbon. At the discussion of M. Violle's experiment at the Académie des Sciences, M. Berthelot pointed out that, in his researches undertaken together with M. Vieille on explosive mixtures of gases, temperatures of 4,500deg. C. were obtained. The comparison of this figure with that obtained by M. Violle shows that the high temperature of the electric arc has been much exaggerated, and that similar temperatures can be obtained and even exceeded by purely chemical reactions.

Specialisation of Accumulators.—Our article with this title has aroused a considerable amount of interest among electrical engineers on the other side of the Atlantic, where the usefulness of the accumulator has hardly yet been fully recognised. Mr. J. K. Pumpelly, whose name is known as a worker in this domain, has a letter on the subject in the *Western Electrician*, of which it may be well to quote certain sentences. "The secondary battery is a thing of chemical mysteries, even to the expert. The specialisation of accumulators is a subject the writer has dwelt upon for more than a year, feeling from his experience that they were only useful in certain places under certain conditions. The battery to aid a lighting plant can be quite a different thing from that used for traction. The heavy battery of great ampere-hour capacity can be made for lighting stations at proportionately less cost than a light, compact battery for traction. The cost of metallic lead, oxides, time, and current occupied in forming (say 60 hours) is the main expense for the lighting plant. The weight of metal gives durability; glass jars can be used instead of rubber, one of the most expensive items in a battery of light weight. If carriages could be rented by the hour from central stations, like horses and carriages from the livery stables, then the rental could be made to pay even if 50 per cent. of first cost were added after six months. Batteries are not like horses; they do not eat unless they work, and do not deteriorate when out of use. There is money for every hour of their use, a small percentage going to restoration and repairs." We saw recently a self-contained steam-driven delivery van of one of the large clothing establishments in Paris. There is no reason why electric vans should not be multiplied and hired out. But special cells will be required.

Parisian Lampposts.—A special meeting of the Blackpool Town Council was held on Monday. The following minutes were submitted for consideration by the Electric Lighting and Tramways Committee: "Resolved that the electrical engineer be desired to obtain tenders for 100 street lampposts for the promenade, 25ft. high to the arc, and of the Parisian design marked Model A now submitted and approved of by this committee, and also tenders for 25 street lampposts for the various streets in the borough, 18ft. high to the neck of the post, and of the design now submitted; that the iron street pipes for the electric light installation be laid on the east side of the promenade, adjoining the west side of the carriage drive, that the Mayor and the Chairman (Councillor Pearson) be desired to give instructions to the electrical engineer as to the commencement of the necessary streets works for the electric light installation. Mr. Councillor Bickerstaffe said that he should like an assurance from the chairman of the committee that a sample of this lamppost of Parisian design would be procured before any contract was entered into. Mr. Councillor Bickerstaffe said that he should move an amendment that it be a recommendation to the committee to procure a sample lamppost before tenders were asked for. The speaker pointed out how deceptive illustrations usually were, and inasmuch as this was a matter which would involve an expenditure of £2,000 or £3,000, they ought not to enter into a contract for the supply of something they had never seen. Small illustrations were very little guide as to what the actual result might be. Mr. Councillor Sergenson supported the amendment, as he had already been deceived in the appearance of lampposts. After discussion, the amendment was rejected, Mr. Pearson stating the design itself as obtained from the founders had been submitted to British founders for tenders.

Electricity in Agriculture.—The series of articles on the application of electricity in country homes in our enterprising contemporary the *Electrical World* has now reached number five. We are treated to a number of illustrations of proposed processes, some useful, others amusing. The fowls are electrocuted by a benevolent boy, looking like Helen's baby, "Budge," who works a high-tension switch and Cardew voltmeter; an electric heater hatches eggs (and even the hatched eggs are chipped by electricity!); ice-cream is made, dumb waiters run by electric motor, while a wheel windmill drives the dynamo. Even our own ancient gibe of accumulators charged by atmospheric electricity is taken up—not necessarily such a chimerical idea, when Teslaic vibrations become at length harnessed to motors, and, as Emerson suggests, we "hitch our waggons to the stars"; for every square yard of ground in tropical sunshine, it is calculated, receives 2 h.p. in solar radiation. Though not efficient, the little sun-motor, described in another note, is suggestive as one step towards the direct utilisation of the energy of the sun. We have suggested a field recently for young electrical engineers in new processes of electroplating. There is another field open for young men of push and adaptation in the profession of electric agriculture, not alone in the application of electricity to the hastened growth of vegetables—though in this one or two men are making small fortunes in "electro-forced" lettuces (borrowing the new-coined word from Mr. Randall's boots—"we thank thee, Randall, for the term!"). But in the scientific application of electric heating and electric motors to country house operations, there is much to be done that would yield a good harvest if taken up, as it should be, in conjunction with the manufacturers of agricultural implements, such as Samuelsons, of Banbury, Fowler's, and the other great implement makers.

Electric Motors in Workshops.—M. Géraldy has given an account of the electric motors as used in the shops of the Great Northern Railway of France, of which the following abstract appears in the *Proceedings* of the Institution of Civil Engineers: "The company referred to, having decided to move a small shop used for their telegraphic service into a position more convenient, and at the same time to utilise an old wooden shed, which would have required considerable strengthening if shafting, etc., had to be accommodated, it was decided to drive the tools by electrical transmission, and to supply each tool with its own independent motor. The current is supplied by the 'Société d'Eclairage et de Force,' whose generating station is in close proximity, at a price of 0·38f. per kilowatt-hour (3½d. per Board of Trade unit). This shop has been running now for a year, and the mean daily consumption has been about 11 kilowatt-hours; so that the daily expense for current is 4·18f., or for power, including depreciation of motors, oiling, renewal of brushes, etc., 5·18f. per day (4s. 2d.) per day). In the former shop a gas-engine had been used, and, under the same conditions, the price for power was a little more than 13f. per day (10s. 4d. per day). The price paid for the current is certainly specially low; but, even taking the price of 0·45f. per hour (6d. per Board of Trade unit), as charged in Paris for an electrical horse-power, the daily cost would amount to only 6·71f. (5s. 5d.), or still at an economy of 50 per cent. over the gas-motor. The paper is illustrated with sketch plans, showing the application of the motors to lathes, a radial drill, a shaping-machine, a grinder and mixer for paint, and a ventilating blower; and a complete tabular statement of the electrical power absorbed when running empty and on load is presented, varying according to the particular tool from ⅛ h.p. to 2¼ h.p., exhibiting at a glance the great saving in power which is claimed for the adoption of independent electrical motors in such cases where the work is intermittent, and the motor can be cut out of circuit when not required. This statement and the principal data are taken from a communication to the 'Revue générale des Chemins de fer,' made by Mr. Sartiaux, manager of the company."

Cantor Lectures.—The first of a series of Cantor lectures before the Society of Arts, on "The Practical Measurement of Alternating Electrical Currents," will be given by Prof. Fleming on Monday, the 30th inst., at 8 p.m. The syllabus of lectures is as follows: Lecture I., January 30. "The Measurement of Alternating-Current Strength." Definitions; Graphic Representations of Periodic Currents; Experimental Description of Current Curves; Analysis and Synthesis of Periodic Currents; Thermal Ammeters; Electro-Dynamometers; Kelvin Balances; Copper-Disc Ampere-meter; Electromagnetic Instruments for Alternating-Current Instruments; Evershed's, Nalder's, Elihu Thomson's, Dobrowolsky's Types of Ammeters; Impulse Dynamometers; Measurement of Very Small Alternating Currents; Methods of Calibrating Alternating-Current Ammeters. Lecture II., February 6th. "The Measurement of Alternating-Current Potential." Definitions of Inductance and Impedance; Laws of Current Flow in Inductive Circuits; Construction of Non-Inductive Resistances; Electrostatic and Electrodynamic Voltmeters; Voltmeters of Kelvin, Ayrton, Swinburne, Cardew, Siemens, Elihu Thomson, Evershed, Nalder, and others; Alternate-Current Potentiometer; Employment of Electrostatic Voltmeters and Non-Inductive Resistances for Current Measurements; Standardisation of High-Tension Voltmeters; Measurement of Capacity of Condensers and Concentric Cables; Capacity Effects in Cables and Condensers. Lecture III., February 13th. "The Measurement of Alternating-Current Power." Apparent and Real Power; Power Factor of a Circuit; Power-Meters or Wattmeters; Electrostatic and Electrodynamic Forms of Wattmeter; Wattmeters for Inductive Circuits; Wattmeters Employed on High-Tension Circuits; Methods of Testing Efficiency of Alternators and Transformers; Methods of Regulating Pressure on Testing

Circuits. Lecture IV., February 20th. "The Measurement of Alternating-Current Energy.' Alternating-Current Ergmeters; Meters for Energy: Shallenberger, Thomson, Brillé, Frazer, Ferranti; Meters for Quantity; Mengarini, Richard, Frazer; Watt-hour Meters or High-Tension Primary Circuits; Methods of Measuring Total Output of Alternating-Current Stations; Efficiency of Supply; Conclusion.

Silvey System of Train-Lighting.—Under the train, whose dim light you usually do not enjoy, is a tank of gasoline at great pressure, and in this apparently-harmless cylinder is sufficient energy to blow the train to atoms. Not only in America do these things happen. At Nantes, in France, a gas-tank exploded, killing 200 people. All this should be in favour of the electric light for train-lighting—harmless and comforting. While we have in England the makers of E.P.S., lithanode, and other cells striving to show the British public (and especially that portion of it known as tramway and railway directors) how to light carriages by electricity, in America the Silvey system has been adopted with success. Those interested should look at the account given in the *Electrical World* for the 31st ult., where the system of Mr. W. L. Silvey is described at length. The Chesapeake and Ohio railroad is equipped in this way, and several other railway companies are adopting the accumulator train-lighting system. At Cincinnati the cells have been working for over eight months, being charged once a week; and another line has had the system in use for a year. The charging station at Covington, near Cincinnati, is carefully arranged, two men being able to take care of batteries for 30 railway carriages. Each carriage has 10 16-c.p. lamps, the batteries being placed in removable trays, slid into permanent boxes underneath the carriages. The plates are made of a metal grating 12in. by 6in. and ⅛in. thick, 21 plates to a cell. These lead plate castings are laid on their side in a bath, and by an electrical process which is original to the Silvey system, they are filled with electrolytically-deposited spongy lead, after which they are placed in a bath which hardens the sponge into a coherent mass, almost as hard as rock, fixed firmly into the holes with a surface layer over the whole plate. These plates are clamped together with lead screws and nuts, thus avoiding all soldering. The battery is seen to be different from other types, and is covered by several patents. The use of chemically pure lead has been found in practice to give an efficiency 22 per cent. greater than is possible with batteries employing a mechanically-filled plate of lead oxide. Between each plate is a separator of porous material, specially treated until practically indestructible, and capable of absorbing four times their own weight of acid, so that the Silvey cell is half way towards being a dry cell with very little free acid to spill. The cell is deep, and a grating is laid on the top to prevent wavelets forming on the cell being shaken. The charged cells are pushed into place from a hand-truck, and two men can change all the batteries for an entire train of average length in 15 minutes. The lamps are fitted with key-switch and fusible cut-out. The cars are all independent, rendering the system as flexible as can be. It has been found in practice that the batteries will light the cars for three nights at one charging, and are able to light a train well for 2,000 miles of journey. Some tables of cost of establishment and maintenance are given: the hourly cost per car for 50 cars, 144 c.p., is given as 1·25d., with one charging plant, and 1·6d. with two charging plants. The system is exploited in America by the Dayton Manufacturing Company of Dayton, Ohio. The absence of dynamo and regulating apparatus, and the absolute flexibility of the system, are leading to its rapid extension on the American railways.

On the Continent.—Messrs. Schuckert and Co., of Nuremberg, have lately completed two central stations, some particulars of which may not be uninteresting; one of these stations is at Christiania, Norway, and the other at Aix-la-Chapelle, Germany. The central station at Aix-la-Chapelle, which was handed over to the Corporation of that town on December 31 last, and which had to be erected and finished in the very short time of five months, is situated in the centre of the town. The whole plant, which is capable of lighting 10,000 incandescent lamps of 16 c.p. each, is divided in three main parts: the boilers, the engines and dynamos, and the accumulators. In the boiler-house there are three boilers, each with 140 square metres heating surface; they are made by the firm of J. Piedboeuf, of Aix-la-Chapelle. The engines, of which at present two sets are fixed, give, with 120 revolutions per minute, an output of 350-420 nominal horse-power each, so that each of them is capable of generating a current sufficient for feeding 5,000 incandescent lamps. The engines are triple-expansion engines with condensation, made by C. Kuhn, of Stuttgart, and the dynamos are of the well-known Schuckert flat-ring system. The accumulator plant consists at present of 140 Tudor cells, type 39A, with a capacity of 1,610 ampere-hours, and capable of discharging 483 amperes. There is sufficient room left in the building for machines and accumulators to put in two more sets of machines of 500-600 h.p. each, and three more sets of accumulators like the above, when required. The cables, manufactured by Messrs. Felten and Guilleaume, of Mülheim-on-the-Rhine, have a total length of about 40 miles; they have a double lead cover, and are, besides, protected by a cover of strong iron band. Dynamos, accumulators, and outer circuit are connected in the manner which Messrs. Schuckert and Co. have adopted for the first time at their central station of Barmen, and later on at their central stations of Lübeck, Hamburg, Hanover, Düsseldorf, and Altona—viz., all three parts are continually in parallel. This means that the difference between production and consume is always stored in the accumulators, or will be delivered to the outer circuit according to the consume being larger or smaller than the production. It further follows from this arrangement that the regulation of the tension in the outer circuit is always done by the regulating switch of the accumulators, which makes it much easier to keep a constant tension in the outer circuit, and to prevent fluctuations of the same. The central station at Christiania, opened on December 13 last, had to be carried out in a somewhat different way than the above, in consequence of the geographical situation of that town, where they scarcely want any artificial light during the summer months, whilst during the winter months the light is required nearly the whole day. The main points, therefore, were the engines and dynamos, and up to now four sets of 100-140, 200-260, and two of 450-600 i.h.p. respectively, have been erected. The engines are compound engines with condensation, the dynamos Schuckert flat-ring dynamos, type J L 10, 12, and 18. There are two boilers of 250 square metres heating surface, and one of 145 square metres, and further, an economiser for 14,000 kilogrammes of water, the latter manufactured by Messrs. Babcock and Wilcox, London. The same system of regulation is adopted as in Aix-la-Chapelle. The provisional accumulator plant, consisting of 138 Tudor cells, type 18, is sufficient for feeding 11,000 lamps of 16 c.p. each, but an enlargement for up to 17,000 lamps is provided for. The cable net has a diameter of about 4,600ft., the length of the cables being about 41 miles.

REVIEWS.

Electrical Papers. By OLIVER HEAVISIDE. Two volumes, pp. 560 and 587. (Macmillan, 1892.)

These volumes contain for the most part reprints of the author's electrical papers published in various *Journals* and *Proceedings* of societies during the last 20 years.

The first part of Vol. I. is devoted to special points of practical interest, such as the measurement of resistances, sensitiveness of instruments, speed of signalling, etc. The twentieth paper, "Contributions to the Theory of the Propagation of Current in Wires," is here published for the first time, though written in 1882.

The next paper, "On the Dimensions of a Magnetic Pole," rather exemplifies the author's mode of dealing with dimensional questions, being written too much from the unitary point of view. For instance, he speaks of K, the dielectric coefficient, as being a numeric in the electrostatic system of units, though not so in the electromagnetic system. It seems a pity nowadays to speak of physical quantities as if their species were subservient to the system of standards chosen for measuring them.

Probably, after the attention that has recently been directed to questions of dimensions, more care will be given by writers on theory to seeing that the expressions used by them to denote physical quantities shall as fully as possible denote the quantities themselves, independently of any special system of measurement. Thus, the force between two magnetic poles $m\,m^1$ is $\frac{1}{\mu}\cdot\frac{m\,m^1}{r^2}$, or rather $\frac{1}{\mu}\cdot\frac{m\,m^1}{4\,\pi\,r^2}$ (see below), when the poles are separated by a distance, r, in a medium of magnetic permeability, μ; the quantity μ should not be omitted merely because we intend to use some special system of units in which μ would be represented by 1. μ (unless against all probability it should finally be discovered to have zero dimensions) cannot *itself* be equal to 1, any more than r can be 1; the statement has no meaning.

In Vol. I., p. 257, the dimensions of P are not completely expressed by $\Sigma\,(\rho/r)$. This expression apparently makes P of lower dimensions than ρ, whereas it has been just stated to be of two degrees higher.

The special mathematical methods of the author are introduced in paper No. xxiv. on "The Relations between Magnetic Force and Electric Current." In connection with this paper, it would be well for the reader who is unacquainted with the author's vector algebra to read his introduction to it in the first paper of Vol. II., and also on pp. 528, *et seq.*, of that volume. A brief outline is as follows: Vector, or directed, quantities are distinguished from undirected, or scalar, quantities, by being written in clarendon type, thus: $\mathbf{A}$, $\mathbf{a}$; their tensors, or magnitude, irrespective of direction, being written A, a, in italics. The addition of vectors $\mathbf{A} + \mathbf{B} + \ldots$, means their composition by the polygon of vectors. The product of one vector by the projection of a second in the direction of the first is called the scalar product of the two vectors, and is expressed by their juxtaposition—thus, $\mathbf{A\,B}$. Such a product is the work done by means of a force $\mathbf{A}$, whose point of application moves through a distance $\mathbf{B}$, the expression $\mathbf{A\,B}$ denoting the product $A\,B\cos(\mathbf{A},\mathbf{B})$. Similarly, the equation $a^2 = b^2 + c^2 + 2\,b\,c\cos(\mathbf{b},\mathbf{c})$, where a, b, c are the sides of a triangle, and $(\mathbf{b},\mathbf{c})$ denotes the angle (180deg. $- A$), which would turn $\mathbf{b}$ into the direction of $\mathbf{c}$, would, in vectors, be written $\mathbf{a}^2 = \mathbf{b}^2 + \mathbf{c}^2 + 2\,\mathbf{b\,c} = (\mathbf{b} + \mathbf{c})^2$, agreeing with the vector summation $\mathbf{a} = \mathbf{b} + \mathbf{c}$.

The author uses the simple juxtaposition form $\mathbf{A\,B}$ for this scalar or directionless product, because it is this scalar product which occurs most frequently in physical investigations. Besides this there is the product which, when $\mathbf{A}$, $\mathbf{B}$ are lengths, denotes the area of the parallelogram of which $\mathbf{A\,B}$ are two sides (when drawn from a point)—*i.e.*, $A\,B\sin(\mathbf{A},\mathbf{B})$. This product is called the *vector product*, and is denoted by $V\,\mathbf{A\,B}$. It is a vector quantity whose direction is normal to the plane containing $\mathbf{A}$, $\mathbf{B}$, and, when positive, is measured towards the spectator if the angle from $\mathbf{A}$ to $\mathbf{B}$ is counter-clockwise.

The author prefers to look at the vectors from behind, and to say the positive direction is away from the spectator if the rotation from $\mathbf{A}$ to $\mathbf{B}$ is clockwise; or, if the rotation is the same as in screwing a right-handed screw, the positive direction is that in which the screw travels (see Vol. I., pp. 431, 447). This latter is the best description for those who can screw a screw, because they may imagine themselves screwing it in or out as they prefer. In a rectangular system of co-ordinates the positive directions of the axes should be drawn according to this law, so that from O X to O Y, from O Y to O Z, and from O Z to O X are all positive rotations.

In the Papers xxiv., xxv., and xxvi., the author distinguishes systems of vectors into two great classes—viz., those which possess divergence without curl, and those which possess curl without divergence. No system of vectors can have everywhere both no curl and no divergence, and, though some systems can possess both, they can be divided into separate systems, of which one possesses curl only and the other divergence only (p. 253). The curl of a vector is itself a vector, whereas the divergence of a vector is scalar.

He defines and describes with great luminousness and care the meanings of both curl and divergence after the manner of Maxwell. The author's whole treatment of the subject is based on Maxwell's theory of the ether as a dielectric.

The divergence of a divergent vector without curl has a scalar potential, and the vector itself at each point has the direction and magnitude of the greatest downward slope of this potential.

The curl of a curling vector without divergence has a vector potential, and the vector itself at each point is the curl of this vector potential. These systems of vectors form closed curves (p. 215).

It is interesting to notice how thoroughly Cartesian expressions indicate their scalar or vector nature. Thus, the divergence of a vector (u, v, w)—that is, a vector whose components are u, v, w—is $\frac{d\,u}{d\,x} + \frac{d\,v}{d\,y} + \frac{d\,w}{d\,z}$; and that it is a scalar quantity is obvious, since each term is the ratio between two parallel vectors.

The curl of (u, v, w) is $\left(\frac{d\,w}{d\,y} - \frac{d\,v}{d\,z}, \frac{d\,u}{d\,z} - \frac{d\,w}{d\,x}, \frac{d\,v}{d\,x} - \frac{d\,u}{d\,y}\right)$.

The terms in the components of this curl perfectly indicate their vector nature and their respective directions. For example, $\frac{d\,w}{d\,y}$, being a ratio between two vectors of which one points along the Z axis and the other along the Y axis, is a vector along the normal to the Y Z plane—*i.e.*, along the X axis. It is taken with a plus sign because the vector, $d\,y$, belonging to the operator, $\frac{d}{d\,y}$, comes before the vector w, and the rotation from the Y to the Z axis is positive. $\frac{d\,v}{d\,z}$ has a minus sign before it, because the rotation indicated by it is in the opposite direction. Similarly for the other components.

The author, in common with quaternionists, uses the letters $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$, to denote directions along the X, Y, and Z axes, but in contradistinction to them, in his system $\mathbf{i}^2 = \mathbf{j}^2 = \mathbf{k}^2 = 1$, instead of -1. Also $V\,\mathbf{j\,k} = \mathbf{i}$, $V\,\mathbf{k\,i} = \mathbf{j}$, $V\,\mathbf{i\,j} = \mathbf{k}$, while the scalar products $\mathbf{j\,k}$, $\mathbf{k\,i}$, $\mathbf{i\,j}$ each $= 0$.

It should be specially noticed that these directional prefixes, $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$, though extremely convenient as laying stress on vector quantities, cannot convert a scalar quantity into a vector, but are merely stamps to call attention to the fact of a quantity being a vector, and to its special direction. It is not indeed, theoretically, absolutely necessary to employ them, though in practice it is, for if u, v, w are really vectors, *completely expressed*—*i.e.*, if all constants involved in them are algebraically expressed so as to show their meanings—u, v, w will each bear on their face their several directions, and $u + v + w$ will necessarily be their resultant, though $\mathbf{i}\,u + \mathbf{j}\,v + \mathbf{k}\,w$ better reminds one that the addition is of vectors.

The operation $\mathbf{i}\,\frac{d}{d\,x} + \mathbf{j}\,\frac{d}{d\,y} + \mathbf{k}\,\frac{d}{d\,z}$ performed on $\mathbf{A} = \mathbf{i}\,u + \mathbf{j}\,v + \mathbf{k}\,w$, gives rise to the scalar product $\nabla\,\mathbf{A}$, or $\frac{d\,u}{d\,x}+\frac{d\,v}{d\,y}+\frac{d\,w}{d\,z}$, and *also* to the vector product $V \nabla \mathbf{A}$, or $\mathbf{i}\left(\frac{d\,w}{d\,y}-\frac{d\,v}{d\,z}\right)+\mathbf{j}\left(\frac{d\,u}{d\,z}-\frac{d\,w}{d\,x}\right)+\mathbf{k}\left(\frac{d\,v}{d\,x}-\frac{d\,u}{d\,y}\right)$.

So also, equally, would the same operation written $\frac{d}{d\,x}+\frac{d}{d\,y}+\frac{d}{d\,z}$, performed on the same vector written $\mathbf{u}+\mathbf{v}+\mathbf{w}$, give rise to the same scalar and vector products, but without **i**, **j**, **k**, of course, in the latter, and without the obviousness of the needful minus signs unless the vector product were thought of as made up of the determinants indicated by

$$\left\| \begin{vmatrix} \frac{d}{d\,x}, & \frac{d}{d\,y}, & \frac{d}{d\,z} \\ u, & v, & w \end{vmatrix} \right\|.$$

It would not do to attempt to express the full vector by addition of its Cartesian components without using the symbols **i**, **j**, **k**, as one would be almost certain to get mixed, particularly in special investigations where the formulæ might have lost their completeness. But where the Cartesian calculus fails is not so much in its inability to express directions with sufficient clearness, as in its emphasising three special directions as if they were more important than any others, whereas, physically, all directions are important alike. Hence, a notation in which a vector in any direction is as easily specified as a vector in one of these three directions is more directly appropriate to physical investigation, though, probably, for purposes of *calculation*, it may be necessary to find its Cartesian components. It may be good to work both systems side by side: as the author says (Vol. I., p. 207) "when working with vectors by the scalar system, there is great advantage to be found in continually bearing in mind the fundamental ideas of the vector system. Make a compromise; look behind the easily-managed but complex scalar equations, and see the single vector one behind them, expressing the real thing."

By "scalar" equations here, the author means vector equations in which all the vectors point along the same line—viz., along one of the three axes of co-ordinates. It is not quite accurate to call them scalar equations, except in the sense that the additions and subtractions involved are simply arithmetical. The quantities are vectors, but collinear ones.

The vector whose direction and magnitude represent the direction and magnitude of the greatest downward slope of a scalar quantity P is given by the operation $-\nabla$ performed on P—*i.e.*, is $\left(-\frac{d\,P}{d\,x}, -\frac{d\,P}{d\,y}, -\frac{d\,P}{d\,z}\right)$ or $-\left(\mathbf{i}\,\frac{d\,P}{d\,x}+\mathbf{j}\,\frac{d\,P}{d\,y}+\mathbf{k}\,\frac{d\,P}{d\,z}\right)$. If this vector is called the divergence of the scalar quantity, being obtained from the scalar by a similar operation performed on it, except for the minus sign, as that by which the scalar divergence of a vector is obtained, the connection between a series of alternate scalars and diverging vectors without curl, A, $\mathbf{B}$, C, $\mathbf{D}$, . . . so related that each is the divergence of the preceding quantity, would be $\mathbf{B} = \text{div } A = -\nabla A$, $C = \text{div } \mathbf{B} = \nabla \mathbf{B}$, . . . and $C = (\text{div})^2 A = -\nabla^2 A$, $\mathbf{D} = (\text{div})^2 \mathbf{B} = -\nabla^2 \mathbf{B}$—*i.e.*, each scalar will be the scalar potential of the next succeeding scalar, and each vector the vector potential of the next succeeding vector (p. 263, where, however, the author calls **B** the space-variation of A instead of its divergence. With humility I suggest the latter term as an improvement).

Similarly, if **A**, **B**, **C**, **D**, . . . are a series of curling vectors having no divergence, such that each is the curl of the preceding vector, then **A** will be the vector potential of **C**, **B** the vector potential of **D**, and so on (pp. 206, 219, 263).

Both these theorems, so far as they relate to vector potentials, are contained in the identity (proved in Vol. I., p. 219), $(\text{div})^2\,\mathbf{A} + (\text{curl})^2\,\mathbf{A} = -\nabla^2\,\mathbf{A}$. This theorem could be written in the form $(\text{div} + \text{curl})^2\,\mathbf{A} = -\nabla^2\,\mathbf{A}$, since the curl of a vector has no divergence—*i.e.*, div curl $\mathbf{A} = 0$ (p. 219), and the divergence of a vector, being a scalar, has no curl—*i.e.*, curl div $\mathbf{A} = 0$. But the first form of the theorem is the more useful, except so far as the alternative second form reminds one of the fact that the curl of a vector has no divergence. This fact shows that in the second theorem it need only be stated that **A** is to have no divergence; the others will necessarily have none.

The fundamental relation between a vector **A** and its curl is that the line integral, or circulation, of **A** round any curve = the surface integral of curl **A** through the curve (p. 211).

One instance of the importance, electromagnetically, of this curl-vector is the fact that the density of an electric current at any point is the curl of the corresponding magnetic force. This is stated by the author, and illustrated by a particular example (pp. 198, 199). The electric current is shown on this hypothesis to have a vector potential, from which the magnetic force is derivable by curling. There is also a scalar potential, called the magnetic potential, in parts where there is no current, of which scalar potential the magnetic force is the divergence or slope—*i.e.*, is derivable from the potential function by the operation $-\nabla$ (p. 234).

Similarly the magnetic current (taken negatively) is the curl of the corresponding electric force (p. 448).

Electrostatic force has no curl. Its divergence at any point equals the density of electrification there, and has a scalar potential, of which the electric force is the divergence (pp. 212, 210).

In this paper, No. xxiv., the author restricts himself to general theorems, not going into particulars, such as what part of an electric current passes through the conductor and what part through the dielectric, nor does he draw the distinction between magnetic induction, **B**, and magnetic force, **H**, of which $\mathbf{B} = \mu\,\mathbf{H}$. The current density is curl **H**, not curl **B**. All this is, of course, fully stated in later papers.

If the ordinary definitions are employed, the current density would be $4\,\pi \times$ curl **H**, instead of simply curl **H**. Similarly, $4\,\pi$ occurs in connection with electric force and electrification. The author urges most strongly the adoption of an improved set of definitions to enable this obtrusive $4\,\pi$ to disappear from these equations. He contends that the strength of the magnetic field due to a magnetic, m, pole should be defined to be $\frac{1}{\mu} \cdot \frac{m}{4\,\pi\,r^2}$, instead of, as now, being equal to $\frac{1}{\mu} \cdot \frac{m}{r^2}$. The new definition is a very reasonable one, as the strength at any distance, r, from the pole would equal total strength divided by the spherical area over which the strength was spread. The actual force between two poles, m, m^1, would be $\frac{1}{\mu} \cdot \frac{m\,m^1}{4\,\pi\,r^2}$.

Similarly, the definition of strength of electric field due to a charge q should be $\frac{1}{K} \cdot \frac{q}{4\,\pi\,r^2}$ instead of $\frac{1}{K} \cdot \frac{q}{r^2}$ as now, and with a similar justification. The author says (Vol. I., p. 432) that he always uses equations based on these revised definitions, and then, for publication, liberally seasons with $4\,\pi$'s to suit the taste of B.A. unit-fed readers.

In the same way, probably, the strength of the gravitational field due to a mass m would have to be $\frac{1}{\gamma} \cdot \frac{m}{4\,\pi\,r^2}$.

It seemed at first a pity that the author in reprinting his papers had not struck out these $4\,\pi$'s and left us with the beautiful symmetrical equations and relations with which he himself works. For certainly the $4\,\pi$'s are irritating beyond measure, and one feels irresistibly impelled to cross them out with pen or pencil when reading. But on consideration it seems that this very feeling of irritation, if caused generally, is the very best means of stirring up discontent with the present system sufficient to secure the desired change. Certainly it has seemed to me that there is a fast-growing willingness to adopt the Heaviside rational system of units, and this is exemplified in the able paper of Mr. W. Williams "On the Relation of the Dimensions of Physical Quantities to Directions in Space," communicated to the Physical Society last June by Prof. Rücker.

Mr. Heaviside discusses the advisability and the probable effect of introducing this system, and of altering the standards of measurement in accordance therewith, in

Vol. II., pp. 575-578. He has also an important footnote on the subject in the same volume (pp. 543, 544); and, as he there states, throughout his forthcoming book on "Electromagnetic Theory," which has been for some time appearing in the pages of the *Electrician*, he is employing rational units.

One particular point to be specially noticed is the importance the author attaches to curl and divergence equations as opposed to the use of potentials. In Vol. II., pp. 172, 173, and in a footnote commencing on p. 541, the author insists on the fundamental importance of the two equations which express the electric current in terms of the curl of the magnetic force, and the magnetic current in terms of the curl of the electric force (see also Vol. I., pp. 447, *et seq.*).

He calls his method of treating electromagnetic problems based on these equations the "duplex method," "since its characteristics are the exhibition of the electric, magnetic, and electromagnetic relations in a duplex form, symmetrical with respect to the electric and magnetic sides." With regard to the potential functions, he says that in this duplex method "potentials do not appear, at least initially. They are regarded strictly as auxiliary functions, which do not represent any physical state of the medium. In special problems they may be of great service for calculating purposes; but in general investigations their avoidance simplifies matters greatly. The state of the field is settled by $\mathbf{E}$ and $\mathbf{H}$, and these are the primary objects of attention in the duplex system."

In the preface the author states with great calmness and restraint some of the difficulties he met with, while as yet comparatively unrecognised, in getting his views published. First at the hands of the Society of Telegraph Engineers, and next by the *Philosophical Magazine*, he seems to have met with discouraging repression, and two years' delay and silence are due to this cause. Scientific bodies can hardly be too jealously cautious before they repress a new writer because his views are not exactly in accord with current opinion. The author expresses his thanks to Mr. Biggs, late editor of the *Electrician*, for keeping a place open for his advanced articles; and one is glad to see that the present editor is wise enough to continue the series of articles in spite of the acknowledged difficulty of their subject.

Among the subjects treated by Mr. Heaviside in these volumes may be mentioned a few not so closely connected with his chief investigation concerning electromagnetic waves, such as the complete theory of cable transmission and of currents along wires, in which the remarkable function of self-induction was for the first time prominently emphasised: and his remarks on the volta force, and on the energy of the electric current (thermo-electric and other) in batteries, on which subjects he has consistently upheld views similar to those combated for by Dr. O. J. Lodge. There are also papers on the induction of currents in cores; on the self-induction of wires; and on long-distance telephony.

The second volume is mainly occupied with his remarkable series of memoirs on electromagnetic waves, most of which are very stiff reading, but relieved here and there by humorous touches, and by indications of a keen insight into actual phenomena acquired purely by familiarity with equations which, whatever they may be to others, are to him full of vivid life.

It is impossible, and quite needless, to review in detail the contents of the two volumes. The author is well known to be one of the mathematical modern "pioneers of science" in the electromagnetic field, and here are his papers reprinted to date. All that seems desirable to do is to call attention to some of the most important papers, and to mention some special points, such as the author's vector algebra, his division of vectors into classes, and his insistance on the importance of "curl" and "divergence," by way of introduction to the books themselves.

These volumes cannot in any way be considered as a textbook for beginners, not by any means because the author's explanations are not good, for, on the contrary, they are most luminous, but because from the very nature of a series of reprints, particularly when the author uses a novel mathematical notation of his own, there must be innumerable repetitions and restatements in slightly different ways of many theorems and explanations; but as a book of reference to a student who is struggling through a textbook, these reprints should be invaluable; for by help of the index at the end of Vol. II.—a most essential addition to the value of the books, and it would be a great assistance to have it also at the end of Vol. I.—reference can be made to any knotty point, and the very repetitions and varied restatements which are against continuous reading, will here be of the greatest help in clearing away difficulties. The volumes, in fact, form a sort of dictionary of electricity and magnetism.

In connection with theoretical hydrodynamics, too, the book will be found most useful, helping one to get at the physical ideas lying at the back of the mathematical formulæ which have to be waded through. For instance, the clearest description of vortex-motion and vortex sheets that I have seen is to be found in Vol. I., pp. 275, 276.

I have spoken of the author's vector algebra as being peculiarly his own. This is true so far as the notation goes, but Prof. Willard Gibbs has worked out an exactly similar vector algebra, the only difference being that for the scalar product of $\mathbf{A}$ and $\mathbf{B}$ he writes $\mathbf{A} . \mathbf{B}$ instead of $\mathbf{A}\,\mathbf{B}$, and for the vector product (which he calls the skew product, from the cross-multiplication of the components of the two vectors) he writes $\mathbf{A} \times \mathbf{B}$ instead of $V\mathbf{A}\mathbf{B}$. Mr. Heaviside's notation seems preferable to use in almost every instance.

Besides this, with the same algebra, Prof. Alexander Macfarlane, of Austin, Texas, has written a pamphlet suggesting another notation. So helpful is this last notation in keeping the reader clear from unexpected pitfalls, of which at first the other notations, especially Willard Gibbs's, are full, that in reading the pamphlet of the latter I translated the formulæ into Macfarlane notation as I went on.

The conclusion I have come to is, that for practical use Mr. Heaviside's notation is by far the best, but that in the early stages of proving fundamental transformation identities, and particularly in working with Prof. Gibbs's dyadics, or linear operators, the Macfarlane dress is most helpful. With use the need of this help disappears. There is no confusion whatever in carrying on the two notations alternatively.

With regard to the claims of this new vector algebra *versus* quaternions, I am not competent to give an opinion of any weight. I only feel, and feel most strongly, that for the square of a quantity to be negative merely because one is choosing to think of its direction as well as its magnitude, is contrary to the spirit of common sense. One may be forced into doing it by the defects of the calculus used, but it seems impossible to view the necessity as other than a sign of imperfection in the calculus. For the ordinary Cartesian calculus does take account, and most rigidly takes account, of direction, though as a rule we do not pay sufficient attention to that fact. All directed quantities in the Cartesian system, if completely expressed, carry their directions on their faces. How then can there be room for the minus sign merely because we choose to take these directions into consideration, when, as I say, willy-nilly, the formulæ themselves have previously taken the matter into their own hands.

ALFRED LODGE.

PORTATIVE ELECTRICAL ENERGY.*

BY J. T. NIBLETT.

If my memory serves me rightly, it was in the year 1886 that I made two communications to the *Journal* of this society entitled "Small Accumulators." In these papers I endeavoured to point out some of the then limited applications of stored electrical energy to scientific as well as economic purposes. Since then great developments both in the methods of manufacturing and in the application of this class of apparatus have occurred, and this evening it is my wish to draw your attention to some of the almost innumerable uses to which portative electrical energy is now being applied, and to indicate some of the channels in which its further development appears to me to be desirable.

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* Communication made to the Physical Society of the Glasgow University, January 27, 1893.

During the last few years but little real improvement in secondary batteries has occurred, so that my paper on "Some Recent Improvements in Lead Secondary Batteries," read before this society two years ago, will still give a fair idea of the technicalities of the various types of secondary batteries now obtainable in this country.

Portative Electricity in Mines.—Both from a humanitarian and from a commercial point of view, it is highly desirable that our coal-miners should be supplied with an absolutely safe illuminant, and it is to electricity that we must look to supply this long-felt want. It has been computed that in this country alone there are no less than a million miners' safety oil-lamps in use.

The evolution of the miner's lamp is somewhat curious It is said that in the early days of coal-mining, fiery pits were worked by the phosphorescence emitted from decaying fish. This primitive and feeble light was superseded by the luminosity afforded by a stream of sparks generated by the friction of a flint disc rotating rapidly against a piece of steel. In the ordinary workings oil-lamps or candles with open flames were used, but owing to the large number of terrible accidents and explosions which occurred through the ignition of mixtures of firedamp and air, coal-getting was a most perilous occupation. Improved methods of ventilation reduced somewhat the number of accidents, but little real progress was made until Sir Humphrey Davy introduced his safety lamp. Davy found that by entirely enveloping a flame with a jacket of fine metallic gauze, it might be taken into an atmosphere of a highly-explosive nature with impunity. By experiment, Davy found that it required a considerable amount of heat to ignite an explosive mixture of oxygen and fire-damp. When an oil flame is surrounded by a highly sensitive heat conductor and radiator such as fine metal gauze, the heat coming from the flame is carried off so quickly that it is scarcely possible under normal conditions to communicate a sufficiently high temperature to an outer explosive atmosphere of fire-damp and air to cause it to explode. Thanks to Sir Humphrey Davy, then, coal-getting has been freed from many of its former risks and horrors.

In spite of the many substantial improvements which have of late been made in oil miners' lamps, they cannot yet be considered as absolutely safe under the varying conditions of actual work in a fiery mine. A gust of wind blowing against an oil lamp may cause the flame to impinge against the gauze covering, and by raising this to a sufficiently high temperature it is liable to cause an explosion. If the lamp be tilted the same thing may occur. A sudden knock or jerk is very liable to extinguish the light in most forms of oil-lamps. The light obtained from the most improved class of oil-lamp is but a feeble glimmer, and when newly trimmed does not exceed a half or two-thirds of a candle-power. Owing to the accumulation of coaldust, corrosion of wick, and other causes, the light obtained at the termination of an ordinary miner's "shift" seldom is more than, say, one-eighth or one-tenth of a candle. A little light, however, goes a very long way in the workings of a coal-mine, and it is really surprising with what an insignificant amount of light a miner will do his day's work.

Although during the last 10 or 12 years many attempts have been made to produce a really practical portable electric miner's lamp, no very satisfactory results have been obtained. Numerous cleverly-designed electric lamps actuated by primary batteries have been tried and have invariably failed when subjected to the crucial test of everyday use. An enormous amount of ingenuity has been exercised in the production of primary battery safety lamps, but owing to their high initial cost, their lack of mechanical strength, or their expense of maintenance, they have so far all proved unsatisfactory and unworkable.

In the early days of electric lighting in coal-mines, M. Gaiffe, of Paris, devised a rather curious form of light-giver. The apparatus consisted of a large Geissler tube, which was rendered luminous by a stream of sparks generated by a small induction coil. The coil and the necessary primary battery to actuate it were strapped on the miner's back, so as to leave his hands quite free. This novel but somewhat inconvenient form of electric lamp never survived the experimental stage.

Portable electric hand-lamps actuated by secondary batteries have proved much more satisfactory, and it is probable that we must look to this form of electrical apparatus for the solution of the miners' safety lamp problem.

Many attempts to produce an effective hand-lamp worked by secondary batteries have been made by Messrs. Swan, FitzGerald, Pitkin, Bristöl, Pollak, Bréguet, and others. Of these, perhaps, Mr. Desmond FitzGerald's "lithanode" miner's lamp has been the most successful. This lamp has been received with marked favour on the Continent, as well as in this country. The "Stella" lamp, the name by which it is known on the Continent, is now manufactured by the Lithanode and General Electric Company. In designing this form of lamp, every precaution seems to have been taken to ensure perfect reliability, and absence of complicated mechanism, so very essential in a miner's lamp, is one of its characteristic features. The full-sized lamp weighs complete about 4½lb., and when fully charged it will give a luminosity of about 1 c.p. for a period of 12 hours without requiring to be recharged.

The "Stella" lamp consists of a small two-cell lithanode battery, mounted in an outer protecting case made of lead-coated steel. A simple form of switch serves to bring the incandescent lamp in and out of action. Charging terminals are formed above the lantern bezel, and are covered by lugs forming part of the cover, so that whenever the lamp is in action the cells cannot be short-circuited, and as a consequence, all possibility of sparking is avoided. As an extra precaution, when the lamp is used in fiery coal-mines, the bezel which carries the glass incandescent lamp protector may be secured against removal by means of a lead locking pin.

According to some comparative tests made in the Rochebelle Mines by a committee appointed by the Académie des Sciences of Paris, the "Stella" lamp appears to have acquitted itself exceedingly well. An account of these trials was recently given by M. E. Masson, in the form of a communication to the Association des Ingénieurs sortis de l'Ecole de Liège. The paper was entitled "Lampse Electriques Portative pour mines." It appears that for the experiments in the Rochebelle Mines a number of both primary and secondary battery lamps were submitted, but of these only four, all of the secondary type, were deemed sufficiently practical to be worthy of consideration. M. Masson's account of the trials is very elaborate and exceedingly interesting. From this paper the following particulars have been taken :

"We have given the 'Stella' lamp an extended trial, and have proved its vast superiority over all others. This also is the impression produced by a report upon 'Miners' Electric Lamps,' laid before the Society of Miners' Industries (Comptes-rendus Mensuele), May, 1891, by a committee composed of the following gentlemen: Messrs. Févre, mining engineer; De Place, director of the Rochebelle Mines; Bossard, director of the Cessous Mines; and Lange, engineer of the Rochebelle Mines.

"The committee in question tested the following lamps, all worked by secondary batteries :

Name of lamp.	Weight of lamp.	No. of cells.	Hours light obtained.
Stella	3·08lb.	2	12 hours.
Pollak	4·18lb.	2	9 ,,
Bréguet..... ...	6·38lb.	3	18 to 20 ,,
Swan	24·20lb.	3	10 ,,

"The 'Swan' lamp is somewhat bulky, but the most recent form of this lamp appears to be more portable.

"The 'Pollak' lamp has its lantern fixed on the top of the battery case, and therefore illuminates in every direction, but this arrangement of lantern is possible in any other type of lamp. In this lamp the connections are not protected against the creeping of the solution, from which cause the lamp rapidly deteriorates.

"The 'Bréguet' lamp tested was not considered sufficiently practical to be placed in the hands of miners. "With regard to the 'Stella' lamp, the committee is of of opinion that 'in its present state it is fit for adoption in the actual working of coal-mines.'"

In the workings of coal-mines the following are some of the advantages to be derived by the employment of electric hand-lamps:

When suspended from the woodwork, in lieu of the oil lamp, it lights up the roof more perfectly where the man's work is located. Moreover, the lamp may without danger be inclined so as to throw a strong light upon the smallest fissures in the roof. Its safety in presence of fire-damp allows of the inspection of badly-ventilated corners, of its being placed closely against the roof, and of the careful examination of ground traversed by cracks from which gas is escaping. Without danger it can be introduced within the cell-shaped cavities left after a fall of ground, and therefore allows of their being examined with a greater degree of safety. These are all small matters; but in the aggregate they lead to the conclusion that the employment of electric lamps would be likely to greatly diminish the number of accidents occasioned by the fall of rock.

The Rochebelle Committee came to the conclusion that the total cost of maintenance per lamp, including interest on invested capital, would range between 1½d. and 1¾d. per shift.

Explosions may be, and doubtless have been, caused by air containing an explosive percentage of fire-damp being caused to pass rapidly through the wire mesh of a so-called safety oil-lamp. Under these circumstances the oil flame partakes of the nature of a blow-pipe flame, which when impinged with violence upon one portion of the protecting gauze, supplies heat to that part with greater rapidity than can be carried off by conduction and radiation, and it thereby causes the gauze to become sufficiently heated to induce violent combustion in the surrounding air.

It has been suggested that on the fracture of the incandescent lamp bulb in an electric miner's lamp, the heat in the filament would be a source of danger should the lamp happen to be in an explosive atmosphere. As a safeguard against any possibility of danger from this cause, various safety devices have been suggested. One maker introduced a system of springs placed behind the incandescent lamp and its glass protector; the idea being that should either receive a blow, they would yield but not break, owing to their elastic mounting. Other makers have devised methods of flooding the incandescent filament with water immediately on the destruction of its containing bulb.

As fire-damp and air, even in their most explosive proportions, require a higher temperature than a red heat to cause them to chemically combine, it is exceedingly doubtful whether an accidental breakage of the glass bulb of a good electric incandescent lamp would induce an explosion even in a very dangerous atmosphere. This, of course, only applies to a well-made and thoroughly-exhausted incandescent lamp, such as those now usually employed in the best forms of electric miners' lamps.

Those conversant with the manufacture of incandescent electric lamps are well aware that a short, thin carbon filament which gives a brilliant white light when enclosed in a good vacuum and a current passed through it, will only emit a dull red light when heated by the same current in air. The difference of light is still more marked if hydrogen or some of its compounds are used instead of air. The explanation is, that air and many other gases are good absorbers and conductors of heat, while a vacuum is a splendid non-conductor. For these reasons no danger need be apprehended from the breakage of a small incandescent lamp in the workings of coal-mines, as the mass of air, or mixed air and gas, would instantaneously carry off the small amount of heat contained in a carbon filament, which under ordinary circumstances is not more than ¼in. long, and of about the sectional area of a human hair. The merest trace of oxygen in the atmosphere is enough to consume such a filament when fully incandesced, and as a consequence the flow of current would immediately be arrested.

One of the most powerful contentions against the employment of portable electric hand-lamps in coal-mines *is that these* lamps do not indicate the presence of explosive or vitiated air. The ordinary Davy oil-lamp is in a measure a fire-damp detector, as by the appearance of its flame the presence of explosive gases can be ascertained, and the quantity approximately measured. Thus, although it is not at all a reliable danger indicator, yet the Davy lamp does afford some sort of protection to the miner whilst working in a treacherous atmosphere.

Many suggestions have been made and several very ingenious appliances devised for the detection and measurement of fire-damp when mixed with air. Ansel's instrument, which depended for its action upon the relative diffusibilities of air and various gases through a porous medium, was at one time thought likely to solve the problem. With this instrument the presence of an explosive gas instead of air caused a partial vacuum which was indicated by means of a delicate aneroid barometer. Instruments which utilised the different conductivities of sound through air and atmospheric mixtures have also been tried; and a method by ascertaining the relative density of air as against mixtures of air and gas, by means of an exceedingly light float, has been suggested. Many chemical tests, such as flashing, etc., have been tried, but with poor success. Among the numerous electrical contrivances suggested and tried for the detection of fire-damp, may be mentioned that of Liveing. In this instrument, the relative luminosity of two exactly similar platinum wires when heated by the passage of an electric current, is made to give the desired indication. One of the two similar wires is hermetically sealed in a glass tube, the other is freely exposed to the atmosphere of the coal-pit. The enclosed wire gives constant luminosity under all conditions, the other varies according to the condition of the surrounding air. Another electrically-worked instrument gives comparative tests of the atmosphere by the amount of heat and light given out when a measured quantity of suspected air is subjected to the heating influence of a semi-incandesced platinum wire.

A type of apparatus which has given some satisfactory results derives its activity from occluded oxygen. Oxygen is readily occluded within the pores of certain metallic and non-metallic substances, and under certain conditions this occluded gas may be made to combine with hydrogen, hydro-carbon gases, and other materials of a gaseous nature. During the combination of the occluded oxygen, say, with hydrogen or a light carburetted hydrogen gas, a considerable amount of heat is developed. Now if the rise of temperature be recorded on a thermometer, a ready means is obtained of estimating the relative amounts of the different gases present in any mixture.

The credit of first suggesting the application of this principle to the detection of fire-damp in the workings of coal-mines is due to Mr. Aitken, of Falkirk.

The author has given some attention to apparatus for indicating, measuring, and recording percentages of gas in explosive mixtures such as are found in coal-mines, gas-works, ships' holds, sewers, and similar places. Several instruments have been devised, all of them based upon the elevation of temperature produced by the combination of occluded gas with another gas or gases.

These detectors have been made so sensitive that they can readily detect $\frac{1}{20}$ of 1 per cent. of coal gas when mixed with atmospheric air.

More recently, other forms of these instruments have been made. One of these is fitted with a clockwork arrangement which revolves a paper-covered metal drum, and is capable of recording the state of the air at all times during, say, the working of a miner's shift, or, in fact, continuously. A still more sensitive and accurate instrument worked by electricity has been devised. In this case the indications are obtained by the varying electrical resistances of two similar coils of wire. By the utilisation of electricity, warnings, both aural and visual, may be obtained. By its means, also, signals and records may be made at a distance.

Electric Safety Lamps.—There are numerous instances when a safe light, if not absolutely necessary, is at least a very desirable acquisition. Notwithstanding the very rapid developments which have been going on of late years in both gas and electric lighting, there can be no doubt that oil-lamps at present light a larger number of homes throughout the civilised world than all other illuminating arrangements put together. In the United Kingdom alone it has been estimated that over 10,000,000 oil-lamps are now in use. There can be no wonder, then, that we are so often startled by the recital of terrible accidents, too often, alas! resulting in agonising deaths. According to the evidence of Mr. Alfred Spencer, of the London County Council, given at a recent inquest, he computed that in this country alone there are annually no less than 300 deaths that may be directly ascribed to accidents with oil-lamps. Mr. Shean, of the Fire Brigade Association, asserts that in his opinion at least 10 per cent. of the house fires are caused by paraffin lamps. Sir Eyre M. Shaw, late of the Metropolitan Fire Brigade, reported that in one year no less than 156 of the fires that occurred in London were directly to be traced to the upsetting of paraffin or oil lamps. Would not the employment of portable electric lamps greatly reduce fire risks and the consequent danger to both person and property?

A small combined secondary battery and lamp would answer admirably as an illuminant for use in such places as stables, drying-rooms, stores, and similar places where the upsetting of an oil-lamp or a candle may be productive of serious casualties. Such a lamp answers exceedingly well as an outdoor light, as the light-giving incandescent filament is hermetically sealed, and cannot be extinguished by a sudden gust of wind, nor is it in any way affected by rain or snow.

If an electric lamp were used by those searching for gas escapes, probably many explosions and fires would be obviated. It frequently happens that coal-gas from the road mains finds its way into conduits used for containing electric-light cables. Under these conditions, if an open light be brought near, a violent explosion is the usual result. Recently, several serious accidents of this description have occurred, and most of these, of course, might have been prevented by using portable electric lamps instead of open lights.

In order to avoid all possibilities of explosions while "rummaging" for contraband goods on board vessels carrying petroleum or other explosives, it has been decided by the Customs Board that their officers shall in future be supplied with electric hand-lamps instead of oil-lamps. Ruby-coloured lights for the examination of imported cases of photographic negatives are to be supplied, in order to obviate the risk of damaging the sensitised plates.

For inspectors when examining gas-meters, which are usually placed in cellars or similarly out-of-the-way places; also as a safe light in gasworks, portable electric lamps are almost indispensable. They may also be advantageously employed by watchmen, policemen, sewermen, and others similarly engaged.

For firemen electric lamps would be of great service. It frequently happens that just at a crucial moment the vitiated atmosphere inside a burning building will extinguish the ordinary form of firemen's oil-lamp.

Portable Electric Lamps for Domestic Use.—When considering the artificial illumination of a house it is usual to legislate for a given number of fixed and permanent lights. To arrange for carrying the illuminating agent, whether it be coal-gas or electricity, to all parts of a house where light is likely to be required is not found to be economical or convenient, and as a consequence in most houses portable lights of some description are always required. As has been already shown, our present system of oil-lamps is somewhat dangerous, and leaves much to be desired. Candles are both troublesome and expensive, and are altogether unsatisfactory. To electricity, therefore, we must now look for supplying us with a safe, healthy, clean, and economical portable light.

The applications of small electric lamps for domestic purposes are almost countless. They form a particularly convenient and safe light for plate-rooms, coal and wine cellars, lumber-rooms, and stores. As a night light they are exceedingly handy, as they are always ready, and may be brought into action at any moment. If used only occasionally and for a few minutes at a time, a good form of secondary battery should retain its charge for many weeks or even months.

Another suggested application of stored electricity is to sterilise the water in domestic filters. The proposition is to pass a small electric current through the water in the base of the filter, and by this means to split up a minute quantity of the fluid into its chemical constituents, oxygen and hydrogen. The nascent oxygen thus liberated is in an exceedingly active condition, so that it will be ready to attack and destroy any living organisms or disease germs and thus render the water both innocuous and wholesome.

Some Applications of Portative Electricity to Medical and other Scientific Purposes.—In the sciences of medicine and surgery, diagnosing is greatly accelerated by convenient artificial sources of light. Owing to its peculiar adaptability to medical requirements, the electric light is very rapidly superseding all other forms of illuminant. Much has already been done, and a large variety of instruments have been made for inspecting by means of small electric lamps various more or less difficultly accessible parts of the human body. Most of these devices provide for the introduction of a very small incandescent electric lamp into the cavity under examination, and the instrument is usually fitted with some arrangement for preventing any inconvenience to the patient owing to evolution of heat from the lamp. This arrangement usually takes the form of a system of small tubes through which a stream of cold water is made to circulate.

These lighting instruments generally provide for the introduction of an object-glass which transmit an image of the part under examination to an eye-piece so placed that the image is received direct, or is diverted by means of a prism in any required direction.

Leiter, of Vienna, in conjunction with Dr. J. Mikuliez, has devised several elaborate electrically-lighted instruments for examining various parts of the body.

One of these instruments, the "gastroscope," consists of a main tube about 25in. long and ½in. thick, the lower end being bent at an angle of about 150deg. The small electric incandescent lamp is covered with a stout glass shade, and is connected by wires which are run inside the tube to a portable battery. By the side of the main tube are placed two other tubes through which a stream of water may be kept flowing during the observation, to prevent the lower end of the instrument becoming heated. The instrument also includes an additional tube for pumping the water into the stomach if this be found necessary.

The optical part of the apparatus comprises a prism and an object-glass. This prism is a right-angled one and acts as a reflector, transmitting the light rays from the side of the instrument right up the main tube. To prevent the glass shades becoming smeared while being placed into position, it is provided with a metal shutter which slides over it, and can be drawn back when required.

It is asserted that the gastroscope can be introduced into the bottom of the stomach quite easily, and being bent, it allows of the different parts being illuminated and examined by merely rotating the tube. During an observation, it is usual to distend the stomach by means of air which is forced into it by the air-bladder shown at the head of the instrument.

When a carbon filament is used in the lamp, the light obtained is exceedingly pure, and exhibits the state of things in their true and natural colours. The battery used is a two-cell accumulator, and the lamp should therefore be either 3·5 or 4·0 volts.

For the examination of the eye, ear, and nose a projected light is usually employed. A variety of instrument of this description are made. One of the most generally useful instruments is that known as the "frontal photophore," which consists of a suitable low-voltage incandescent lamp mounted in a metal tube, fitted with a lens in front and backed by a concave mirror. The lens and mirror concentrate and project the light, so that with a small battery an illumination varying from 1 c.p. to 10 c.p. or even 12 c.p. can readily be concentrated upon the part being examined.

The instrument is fixed to the operator's forehead by means of an elastic band or leather strap, and as the lamp-holder is held by a ball and socket bearing, it can be turned in any direction at the will of the operator. Two flexible insulated copper wires serve to connect the instrument to the battery.

In veterinary surgery, electricity has been recently introduced as a means of illuminating laryngeal mirrors. The ordinary mirror, which at its outer end has a small electric incandescent lamp, is introduced into the nostril, and at once renders apparent any symptoms of nasal mucus or other disease which may call for the prompt isolation of the animal. The operation is said to have proved effective even in the case of obstinate horses, while a quiet animal will submit to it without resistance.

Secondary batteries not only lend themselves exceedingly well for lighting purposes in the operating-room, but owing to their very low internal resistance they are also well suited for giving a large current, such, for instance, as that required to heat a platinum or platino-iridium wire when used for medical cautery. For driving small electro-motors, such as are used in dentistry and some surgical operations, they are coming into extensive use.

It is well known that most astronomical observations are made at night, and preferably in the absence of all artificial illumination. It is found that correct observations can only be obtained when the eye has become accustomed to the absence of all light except that coming through the instrument itself. Artificial light tends to temporarily blind the observer, and is therefore liable to impair the correctness of the observations. On this account electric lamps of small power, and which can be brought into action and extinguished instantaneously, are much appreciated for temporary illumination in an observatory. Another advantage attendant upon their employment is the fact that they are not affected by windy weather, and as most astronomical observations are either made in the open air or in a telescope-house with the roof partly off, this alone counts much in their favour.

When making telescopic measurements by means of a micrometer, electric lamps have been found exceedingly useful for illuminating the wires. Arrangements may readily be made either for projecting the electric light rays directly upon the wires themselves, or for lighting part or the whole of the "field." For this purpose a very small amount of light is required, about 1 c.p. being ample in most cases.

Small detachable electric lamps have also been used for directing telescopes to any particular object by means of their "setting" circles. Setting circles are a usual attachment of most telescopes, whether of the reflecting or refracting type, and at times much difficulty is experienced in getting the proper setting without introducing a light of sufficient power to temporarily spoil the eyes for immediate observing.

Another use for the electric lamps is to illuminate clock dials or the semi-transparent screens used by some observers for sketching or making notes of any phenomenon that it is desirable to record.

In stellar photography, the intense white light given by a somewhat over incandesced incandescent lamp when placed in the focus of the object-glass, is found to effectually imprint *réseaux*, or network of fine lines, on the sensitised plate. As the impression produced by this means is very distinct, accurate measurements from the "developed" plate may be readily obtained. When photographing the heavens, the value of these *réseaux* cannot be over-estimated, for by their use the positions of the stars on the plates can be rapidly and easily ascertained. A small electric lamp of from 1½ c.p. to 2 c.p. and an exposure of about 30 seconds is said to be enough to produce the desired result.

Where equatorially-mounted telescopes are driven by clockwork which is electrically controlled, secondary batteries, owing to their constancy and capability of giving occasional discharges of large quantity, are much superior to any other form of battery. For time-signalling also, they may profitably replace the primary cells originally used for this purpose.

For meteorological purposes electric hand-lamps are much in vogue. They are not in any way affected by inclement weather, and as a consequence a steady light may always be relied upon. This is no small matter, as most stations where meteorological observations are made are in greatly exposed positions. Owing to the comparative absence of heat in these lamps, they are well adapted for taking accurate readings from delicate standard thermometers and barometers, especially when these instruments are fixed in dark places, or when readings have to be taken during the night. When these lamps are employed, no error arising from transmitted heat need be apprehended.

Owing to the purity and steadiness of the light obtained from small incandescent lamps, together with the minute dimensions of the light-giving source, these lamps are coming largely into use for illuminating well-appointed microscopes.

Small electric lights are now used for illuminating the circles of theodolites, and the scales of instruments used for determining the earth's varying magnetic force.

When making electrical measurements, electric lamps are being substituted for the old oil-lamps as a means of obtaining the light-spot for reflecting galvanometers, magnetometers, and other similar measuring instruments. For submarine and overland telegraphy, these lamps are vastly superior to other illuminating sources for producing the light-spot when mirror instruments are used. For actuating electric telegraphs, telephones, and similar instruments, secondary batteries are very rapidly superseding the old and troublesome primary batteries. At sea again, time determinations made by sextants are more easily managed if the light is derived from an electric lamp.

To M. G. Trouvé, of Paris, is due the credit of devising a very ingenious piece of electrical apparatus which appears likely to be of much service to geologists, mineralogists, and others similarly engaged. This new instrument has been christened the "erygmastoscope," and its object is to facilitate the inspection of rock strata which have been pierced by the boring tool.

This apparatus, which in general principle somewhat resembles the gastroscope already described, consists of a powerful electric incandescent lamp enclosed in a cylindrical case to preserve it from injury. One side of this protecting case serves as a reflector to project a strong beam of light through the other side, which is of thick glass, and thus the opposite portion of the boring becomes strongly illuminated. A peculiarly-shaped mirror is fixed just under the lamp in such a way that an image of the illuminated portion of the boring is reflected from it upwards to the surface, where it is received by suitable lenses and can be examined by an observer. The upper part of the lamp bulb is rendered opaque, so as to prevent any direct rays from the incandescent filament ascending the boring and rendering the reflected image less distinct. The cables which carry the current through the lamp also serve to suspend the instrument, and by means of these it can be raised, lowered, and turned, so as to bring any portion of the boring within view. The two cables are wound on a drum, and are attached one to each of its trunnions, which are insulated from each other. These trunnions are connected, by means of a pair of rubbing contacts, to the poles of a portable secondary battery, which thus supplies a continuous current to the incandescent lamp; and this current remains constant while the whole apparatus is raised, lowered, or turned about in any way. The erygmastoscope has been found to work satisfactorily to a depth of 600ft., and no doubt with a more powerful lamp this distance might be considerably increased.

In photography, the electric light seems destined to play a most important part. Not only are electric lamps exceedingly useful in the developing-room, but they are being applied to a variety of purposes in the studio, where as a means of illuminating objects at night, incandescent or small arc lamps are now coming into extensive use. Such lamps may be readily and economically worked from portable secondary batteries. In the process of "enlarging," brilliantly-lighted incandescent lamps form an excellent substitute for daylight. Printing photographs by means of the rays emitted from an arc lamp is quite feasible. In the art of lithography, for the reproduction of pictures and diagrams by the process known as "zincogravure," the electric light is rapidly superseding both daylight and all other forms of illuminant. Lecturers and others have found what are known as "focus" incandescent electric lamps to answer effectively as an illuminant for magic lantern slides. Stored electrical energy when used for running the focus lamp is easily managed, and is far safer than compressed gases such as are used for the limelight, or the more common oil-lamps. For lecture purposes electric hand-lamps should be of much service, as they are quite portable and easily managed, while the light can be so arranged that it only illuminates the lecturer's notes, and need not be seen by his audience. In electrical laboratories, and for a great variety of electrical testing purposes, it is very desirable to have a reliable and convenient high-potential developer. Small secondary batteries, owing to their large current capacity and low internal resistance, are well suited for this purpose.

Some Uses of Portative Electricity in the Army and Navy.—In military as well as naval operations, portative electricity is now playing a most important part, and it appears likely that it will be far more extensively used in the future. Not only can secondary batteries be employed for actuating field telegraphs, telephones, and similar signalling apparatus, but electric searchlights may readily be worked by them. For field engineering purposes, or for ordinary excavating at night, an arc lamp run from a set of secondary batteries placed in a waggon is found to give excellent results.

Mr. Eric Bruce's electric war balloon is said to afford a ready means of signalling at night over long distances, and in positions where, owing to the nature of the ground, the ordinary methods of "flash" signalling are impracticable. This apparatus is exceedingly simple in construction, and is quite portable. It consists of a balloon about 18ft. in diameter, made of a material that is quite translucent, with a number of incandescent lamps, supported on a specially constructed holder, placed inside. Usually, the balloon contains six 16-c.p. 24-volt lamps. These lamps are connected to a suitable secondary battery on the ground by means of stout wire cables. The cables serve to release and lower the balloon, which is of the "captive" type. In the electric lamp circuit is placed an apparatus for establishing and breaking the circuit rapidly, and by varying the duration of the flashes of light thus obtained it is possible to transmit signals on the Morse or any other prearranged code. With the aid of a transparent balloon interiorly lighted, a hill, or even a mountain, lying between two friendly parties, should form no barrier to inter-communication.

As a means of "sighting" heavy guns at night, small electric lamps are coming largely into use. Several methods of illuminating the sighters are now in operation. These illuminating arrangements may either consist of a separate piece of apparatus, or they may be adapted to the existing gun sighters.

Captain Grenfell prefers to use a small pencil of light, either white or coloured, reflected by minute metallic mirrors, placed at such an angle that the light is projected parallel to the axis of the gun.

Captain McEvoy's night-sighter consists of a socket fitting on the ordinary daysight, and carrying a small electric lamp inside it. The light emitted by the lamp illuminates a small glass pyramid which forms the tip of the foresight. The light in the rearsight is obtained in the same manner, but in this case the lamp illuminates a wire placed above it, this wire forming the crossbar of the letter "H," which is mostly used in the navy for the rearsight of their guns. To distinguish the rear from the foresight, a red light is used with the former. The red colour may be produced either by colouring the electric lamp, or by painting the cross with some red pigment.

No steamship can now lay claim to being thoroughly well appointed unless it is fitted with electric light. In a steamship the necessary motive power for a dynamo can always be obtained, and as the safety and comfort accruing from the employment of electric lamps is so very marked, the troublesome oil-lamps are now rapidly disappearing from this class of vessel. As a precaution against the breakdown of the electric light machinery and the consequent failure of the light, or even as a regulator to steady and compensate for any irregularities of the dynamo, secondary batteries are being largely used in installations on first-class ships.

Much in the same way as with an electric light installation in a dwelling-house or public building, it is not found to be economical to carry the electric light mains to all parts of a vessel, and it is therefore desirable to have some form of portable electric lamp handy. These portable batteries or combined batteries and lamps can readily be recharged from the ship's mains.

In war vessels the electric searchlight is of great service, not only for reconnoitring purposes, but in time of war the powerful light is almost absolutely necessary for warding off a night attack of torpedo boats. Modern torpedo boats move about with great rapidity and almost noiselessly, and as they are of small dimensions they are not easily detected. By the aid of powerful searchlights, very small objects can be observed, even when at long distances from a vessel.

At night time when steam vessels are passing through narrow water channels—such, for instance, as a canal or navigable river—some means of artificially illuminating the course is absolutely necessary. The rays of a powerful arc lamp, when suspended in front of a vessel, are found to afford an excellent light for the safe guidance of the vessel. For small steam launches, electric launches, torpedo boats, and similar craft which lie low in the water, the electric lamp may be placed on deck.

For night exploration in shallow rivers and similar situations where a steam launch could not go, a set of secondary batteries placed in a row-boat are a convenient substitute for the usual dynamo. These cells can be so constructed that they will effectually work a small searchlight of sufficient power and penetration to cast a fairly strong illumination on the course or banks of the river.

For the propulsion of torpedos and submarine boats, secondary batteries have met with a fair amount of success. Light-buoys, and other similar danger signals, may readily be illuminated by the same means.

As a substitute for steam or petroleum, stored electrical energy is now being largely employed to produce the motive power for launches, not only in fresh water but also at sea.

The spectacle of an electrically-propelled launch on the River Thames, or other of our British rivers or lakes, which a few years ago was quite a novelty, is now so frequently seen that it scarcely excites any interest. Probably the time is not far distant when electricity will drive all other rivals from the field, not only for the propulsion of small pleasure boats but also for ships' pinnaces and similar small craft.

When engines and boilers are used the dust and dirt inseparable from their working is exceedingly objectionable, not only to the occupants of the launch, but to all persons in its neighbourhood. These objectionable characteristics have always been an obstacle to the use of steam-engines for small pleasure launches, and most people when on pleasure bent prefer the slower and more primitive sailing yachts.

A launch fitted with a good form of secondary battery when once charged is always ready for use, and may be brought into action at a moment's notice, while the time of discharge may be spread over days or even weeks. With a steam launch, loss of time is always incurred in getting up steam and otherwise preparing the machinery, so that when only required for a short time the outlay is somewhat heavy.

To the submarine diver some form of artificial illuminant is absolutely essential, as at night time, or when at any considerable depth under the water, little or no natural light can be obtained. Incandescent electric lamps are well suited for furnishing the requisite light for submarine exploration, for the removal of wreckage, or for laying masonry foundations, such as those of piers, breakwaters, harbour walls, etc.

Portative Electricity as Used for Lighting Vehicles.—Hitherto, during the dark hours, the time spent in railway carriages, omnibuses, and similar public conveyances has been practically lost to most men of business and others of an active turn of mind, owing to the absence of any adequate lighting arrangements. At the present time, however, the electric light is being gradually introduced into these conveyances, and it is at last becoming possible to read with something akin to comfort, so that travelling by night either by road or rail is beginning to lose much of its former tedium and irksomeness.

In railway carriages, the flickering and uncertain flame of the ordinary oil-lamp with its attendant unpleasant odours has always been most unsatisfactory, and cannot be said to be free from its dangers. Compressed gas is troublesome, liable to be extinguished either by a gust of wind or by the concussion produced by the jolting of the carriage, and in the case of a collision it is always a great source of danger. A considerable number of fires, many of them entailing much suffering and loss of life, have already been caused by the ignition of the escaping gas when the conducting pipes have been accidentally ruptured, as invariably happens in the case of a collision.

The electric light, if properly installed on an ordinary train, should be absolutely steady, and as its manipulation is exceedingly simple and its cost small, it is difficult to understand why, with our present knowledge of the methods of applying electricity, so few railway trains are lighted by this safe and pure illuminating agent.

An electric current obtained directly by driving a dynamo off one of the axles of, say, the guard's van, is found to be very unsteady owing to the necessary variations in the speed of the train, and also to the frequent stoppages, and as locomotive engineers do not appear to favour a separate engine and dynamo worked from the boiler and placed on the locomotive carriage itself, it is now usual to obtain the light through the medium of secondary batteries.

In this country the usual plan adopted for electrically lighting railway trains is to run a small automatically-regulated dynamo off the axle of the guard's van, and to charge from it a set of secondary cells placed in the same van. By means of the automatic arrangement, the dynamo is brought into action as soon as the speed of the train is sufficient to develop the requisite E.M.F. for charging the cells, and it is cut out again whenever the train either exceeds or falls below certain defined limits of speed. As the cells always have some current in them, and as they always are under the control of the guard, the lights may be switched on during the passage of the train through a tunnel in the daytime, and at night the light may be obtained even when the train is at rest.

On the Continent and in America, where trains make very long runs and are frequently broken up into various sections, it is usual to provide a number of small specially-constructed waggons fitted with a set of secondary cells of sufficient capacity to run the whole journey, and to attach this to the section of the train it is intended to light. These trains do not generate their own electricity, and therefore provision is made for recharging the cells or reinstating newly-charged ones at various stations along the route.

So far but little has been done with self-contained electric lamps for railway-carriage lighting, for the engines or guards' vans, or for signal purposes; but this state of things will doubtless be altered when railway-men have realised the convenience, safety, and economy to be derived from their employment.

Recently, some successful attempts have been made to illuminate several of the London omnibuses by means of electricity. The Lithanode Company, of Westminster, have installed their system of lighting in a number of the London Road-Car Company's vehicles, and, as this system has been in daily operation during the last 12 months, and may therefore be considered to be out of its experimental stage, some particulars as to its practical application may be of value.

The apparatus consists of a small five-cell lithanode battery, weighing about 25lb., and mounted in a stout wooden box. This battery is capable of discharging at a uniform rate of one ampere, and at an E.M.F. of 10 volts, for a period of from 18 to 20 hours when it has been fully charged. On the outside of the wood containing-box are two brass plates which constitute the positive and negative terminals of the battery. A wooden box of somewhat larger dimensions is fixed under the driver's box, and into this the battery is lowered. Two brass springs fixed inside this outer case form the terminals of the connecting wires, and these are so placed that they engage the two contact-plates on the battery, and thus serve to establish contact between the battery and lamp. By adopting this method, no loose terminals or connectors of any kind are employed, and all danger from defective or imperfect contact is obviated.

The lantern, which may be fixed in the centre of the omnibus roof, or in any other convenient position, consists of a small specially-made incandescent lamp fitted with bayonet-jointed shoe terminals, and backed by a plain white reflector. A stout and thoroughly-annealed glass dome is used to protect the incandescent lamp against injury. The wires coming from the lamp are run in wood casing, and go down to the outer containing-box, and then through the spring terminals to the battery. A circular switch is placed behind the lamp bezel, and by giving the dome a slight turn the 'bus conductor can throw the lamp in and out of action.

The elements in the batteries used are of the latest type of lithanode, and special precautions are taken in their manufacture to prevent damage either through the jolting of the vehicle or by rough handling. The battery can be reinstated in a few seconds, as the operation merely consists in removing the exhausted battery and dropping in a newly-charged one. The spring terminals already described automatically establish contact between the lamp circuit and the battery.

In practice, the recharging operation has been found to be very simple, and it may be accomplished in about six hours. According to the present tentative system of maintenance, the batteries are taken to the Lithanode Company's works each morning and are brought away recharged in time to be placed in the omnibuses for the same evening's work. It is believed that the cost of maintenance of these batteries if installed in sufficient quantities would be less than the present cost of the oil consumed. Each of the batteries if completely discharged requires the expenditure of 250 watt-hours of electrical energy to recharge them, and as it has been frequently demonstrated that 1,000 watt-hours can be produced at a cost of about 2d., it follows that the cost of the requisite electrical energy for each recharge should not exceed ½d. Under existing circumstances the batteries are never more than half discharged, so that the cost of electrical maintenance of these batteries may be fairly stated to be about 2d. per week.

Traction by Means of Portative Electricity.—Methods of vehicular locomotion by means of electricity is a subject which must very shortly be seriously considered, not only by our electrical engineers, but by all those responsible for the regulation of traffic in all our large towns. Our present system of horse traction is open to many objections, not only from a humanitarian point of view, but from its sanitarian and economic aspects as well. The streets of our large towns would present a very different aspect if electricity instead of horses were employed for drawing our vehicles. Possibly for regular services of passenger cars, such, for instance, as our tramcars, the methods of conveying the electricity for producing the necessary motive power through overhead conductors, along one or both of the carriage rails, by separate insulated high-conductivity conductors, or by the "picking up" system, may be found to be both practical and economical; but for by far the greater part of our road traffic, these methods of traction are entirely out of the question. Before electric traction can ever hope to be satisfactorily established in our thoroughfares, some independent and self-contained method of driving our vehicles will have to be devised. For this purpose, then, the employment of some form of apparatus worked by stored electrical energy seems to offer the most promising solution of the problem.

In this country most of the battery-driven cars are labouring under the disadvantage of their cells having to be removed from the car while being recharged. This removing operation tells very seriously upon the battery elements and the cell connectors, and is, perhaps, the most fruitful cause of the very rapid depreciation often experienced in the working of electrically-propelled road cars.

From time to time Londoners have been regaled by the sight of an electrically-driven omnibus, a glaring electrically-propelled advertisement car extolling the merits of some patent medical nostrum or fancy soap, or an electrically-driven tricycle, but so far, curiously enough, nothing of a particularly practical nature has been seen. Why traction by means of stored electrical energy is so exceedingly back ward it is difficult to conceive, especially as several fairly good and suitable batteries are now obtainable. Perhaps when lighter, more robust, and less expensive storage cells are made, carriage-builders and others will turn their attention seriously to the manufacture of passenger and other cars suitable for this mode of propulsion, and then we shall be spared the humiliation of seeing abilities thrown away in endeavours to adapt electricity to unsightly vehicles that are built to suit, and can only be properly drawn by, horses or mules.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 43.)

It was explained that when a mass of iron, like an iron bar, was introduced into a space previously occupied by air in which a magnetic field existed, as the interior of a solenoid, the number of lines of force were greatly increased, so that for one line per square centimetre through the air, probably 1,000 per square centimetre would thread their way through the iron. The iron appears to have a sort of "multiplying power"—this property of the iron is named its "permeability," a matter of great importance. Permeability may be considered in some degree as an analogue to specific conductivity in the electric circuit, but there is this great difference. Specific conductivity remains constant, neglecting rise and fall of temperature of the wire, irrespective of the amount of current, whereas permeability is not constant for varying number of lines—so inconstant that its values for the same piece of iron may range from unity to several thousand, the permeability of a vacuum is arbitrarily fixed at unity. That of air is so near that it is practically unity also, the same with all the so-called non-magnetic bodies, and their permeability may be regarded as constant whether the number of lines be few or many. Dia-magnetic bodies have what may be termed a negative permeability—that is, they repel or turn aside part of the lines of force, so that if a piece of bismuth were placed in a magnetic field it would have a "reducing power," and of the number of lines that would flow through air, ·9998 of the number would flow through bismuth, or for 10,000 that pass through air, 9,998 would flow through bismuth, the remaining two being repelled.

The number of lines of force per square centimetre that flow through air and form a magnetic field are denoted by the letter H. When iron displaces the air, the increased number of lines per square centimetre that now pass through the iron is named the "magnetic induction," denoted by the letter B. The ratio of B to H indicates the multiplying power of the iron, or its permeability, denoted by the Greek letter μ, hence $\mu = \frac{B}{H}$, and $B = \mu H$.

Suppose in an air-space there are four lines per square centimetre, and the air is displaced by soft iron, the lines through the iron will be, say, 9,000, hence the value of μ will be 2,250, and this is the multiplying power of the iron; or we may say that the iron conducts or receives the magnetism 2,250 times better than air does. Now let there be 200 lines per square centimetre in air, again displaced by iron, we shall only get 18,000 lines; hence μ is now only 90. From this it is evident that the permeability decreases very rapidly in value as the iron becomes more saturated with lines—that is to say, the greater the magnetic induction the less is its multiplying power. When a certain degree of saturation has been reached, it is unprofitable to force more lines of force through the iron, because, owing to the diminished value of μ, an enormous magnetising force would be required. In the following tabulations are given figures calculated from experiments made by Dr. Hopkinson on specimens of annealed wrought iron and grey cast iron, and these figures represent fairly the quality of the iron used by dynamo-makers.

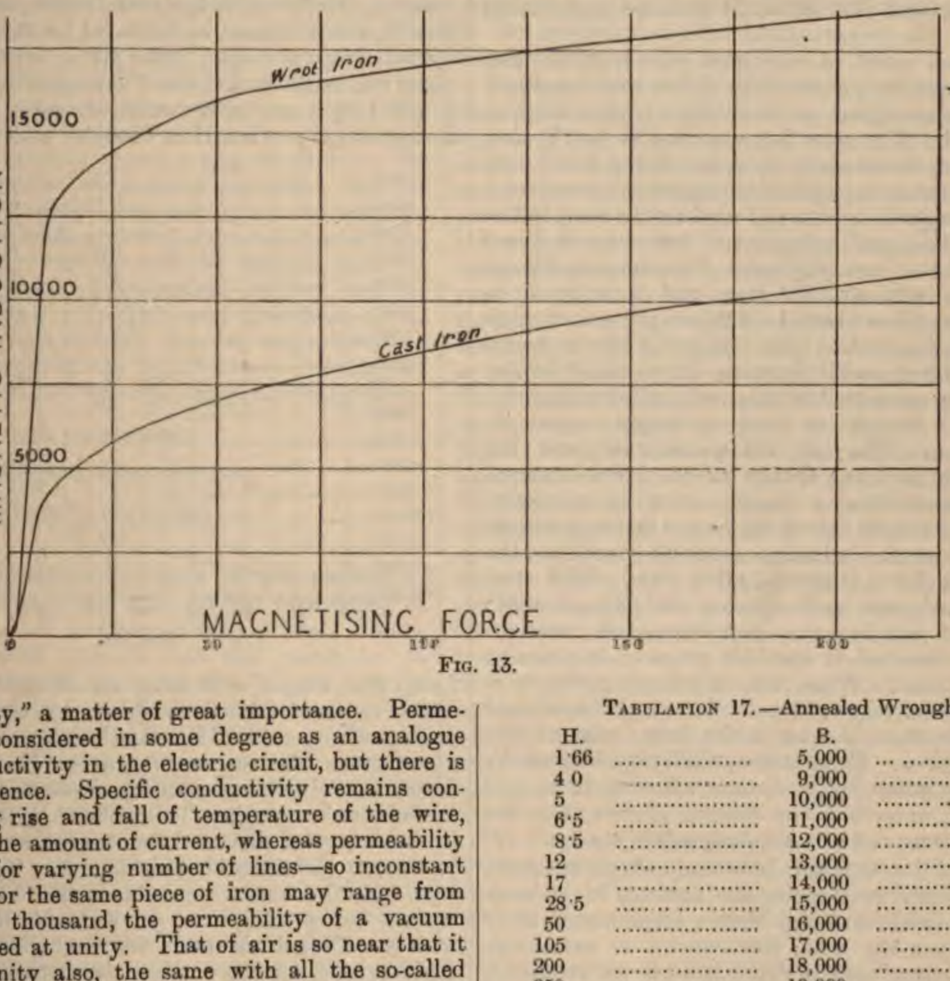

FIG. 13.

TABULATION 17.—Annealed Wrought Iron.

H.	B.	μ.
1·66	5,000	3,000
4·0	9,000	2,250
5	10,000	2,000
6·5	11,000	1,692
8·5	12,000	1,412
12	13,000	1,083
17	14,000	823
28·5	15,000	526
50	16,000	320
105	17,000	161
200	18,000	90
350	19,000	54
660	20,000	30

TABULATION 18.—Grey Cast Iron.

H.	B.	μ.
5	4,000	800
10	5,000	500
21·5	6,000	279
42	7,000	133
80	8,000	100
127	9,000	71
188	10,000	53
292	11,000	37

H signifies the magnetising force, or the number of lines of force per square centimetre that there would be in air.

B signifies the magnetic induction of the iron, or the number of lines of force per square centimetre.

μ signifies the permeability, or multiplying power of the iron.

In Fig. 13 these values are plotted into curves, values of B being plotted horizontally, and those of H vertically; the lower curve being for grey cast iron, and the higher curve for annealed wrought iron. On referring to Tabulation 17, it is seen how enormously the permeability is changed, descending from 3,000 to 30, whilst in Tabulation 18 it drops from 800 to 37. It is interesting to carefully follow the curve, as it gives a good idea of how the iron is gradually magnetised. First, the two values, H and B, increase fairly together, and this part of the curve is plotted from small values of H and B, not given in the tabulations; a little further on the curve takes a sudden upward direction, almost perpendicular. This means that a very little increase of H gives an enormous increase to B. The curve now bends round and then pursues its course in a straight line, still rising, so that it makes a gentle angle above the horizontal. Beyond the bend, the value of B increases very little as compared with H, just the opposite to the state of affairs below the bend. For example, with B at 19,000, and H at 350, it requires nearly double the magnetising force in order to send an additional 1,000 lines through the iron. The curve may be divided into three portions—the straight part below the bend, the bend, and the straight part beyond the bend. In the first part, the iron may be looked upon as being unsaturated; in the third part, as approaching saturation.

The dia-critical point of saturation signifies that point on the curve where the permeability of the iron is reduced to one-half of its maximum permeability, or when the iron is half-saturated. The curve for cast iron is much after the same shape as for wrought iron, but being below iron shows that it is not so susceptible to magnetism, therefore it requires more magnetising force to produce the same induction as iron. The dia-critical point of saturation is about three-quarters that of wrought iron. Dynamo magnets are mostly made of soft wrought iron, and it is usual in dynamo design to allow about 14,000 lines per square centimetre. A greater induction than this would not be economical, because for a small increase there would be the expense of a very much greater magnetising force required, and it would be cheaper to design a larger magnet by using more iron. The last few years cast iron has been used with success. Owing to its lower susceptibility and permeability, a larger mass is necessary. The advantages for it are that it can be cast into any desired shape, and the cost of production is made much less, the economical limit for it is about 10,000 lines. Mild steel has also been adopted, and answers its purpose well; its permeability lies between cast iron and wrought iron, and where the steel is specially prepared it is almost as good as the latter. When the greatest susceptibility is wanted, iron of the very softest kind must be used, and for this, Swedish charcoal iron is the best; next to this comes Lowmoor iron. Great susceptibility is obtained by heating the iron white hot, and then allowing it to cool down gradually, extending the cooling process, say, for several days, by burying it in sawdust, ashes, etc.

When a bar of iron that has been magnetised, is caused to lose its magnetism by stopping the current in the magnetising coils, it will be found that a certain amount of magnetism is left in the iron; this amount is named the "residual magnetism," and is dependent on the retentiveness of the iron—the softer the iron the less is its retentiveness. Iron that has been hardened by any process such as hammering, rolling, etc., possesses more retentiveness. The hardness of iron depends on the amount of carbon in its composition. Mild steel, like wrought iron, has very little carbon; hence, they are soft, possess high permeability, and low retentiveness. The more carbon there is, the harder becomes the metal, such as hard steel, etc.

No two pieces of iron display the same permeability, and in a number of cases it has been found that two lengths cut off the same bar differ greatly in permeability. It is a matter of the highest importance for a dynamo builder to become acquainted with the magnetic quality of the iron he buys, otherwise his calculations are thrown wrong. The following high values of induction, B, or lines per square centimetre, have been obtained by Dr. Hopkinson: 18,250 for wrought iron, 19,840 for mild Whitworth steel, 11,000 for cast iron, and 12,408 for malleable cast iron.

Foreign elements in the iron make a very great difference to the permeability, such as tungsten, manganese, sulphur, chromium, aluminium, etc. Upon adding about 12 per cent. of manganese, a compound is obtained which is almost non-magnetic. The temper of the metal has also an effect upon its magnetic qualities. All magnetic bodies, particularly iron, resist any alteration of their magnetic condition, those which are magnetised oppose any attempt to demagnetise them, and those which are not magnetised oppose being magnetised; and generally, at whatever stage of magnetisation any body may be, there is always a certain opposition shown by the body to any change of its magnetic condition. From this it is very clear that a body which is being continually magnetised and demagnetised, will continually be opposing the continual change of condition.

Such a state of affairs is exemplified by the action of an alternating current upon a mass of iron. The iron is first gradually magnetised, due to the rise of current flowing in one direction; it is then gradually demagnetised by the falling of the current; the current again rising, but flowing in the opposite direction, again magnetises the iron, and again falling demagnetises it. These operations are called a magnetic cycle, and are shown by Fig. 14. At the point O the iron has no magnetism. Upon the magnetising force, H, increasing, as indicated by horizontal values, the magnetic induction, B, also increases, as indicated by vertical values. This increase stops at point C, thus giving the curve O C for the rise of magnetism in the iron. The magnetising force, H, which is now 100, is gradually decreased, and so the iron becomes demagnetised; when H is brought back to zero it will be found that, instead of B being also brought back to zero, it has a value of 10,000, as shown by the point B on the demagnetising curve C B. As the current now changes its direction so the magnetising force, H, also changes its direction, and this is shown by negative values plotted to the left of the zero line. This value of B—namely, 10,000—is what is termed the "residual magnetism" of the iron, and its amount varies considerably according to the nature of the iron. Hard iron, as steel, holds on to its residual magnetism, while soft iron, as wrought iron, easily parts with it. To get rid of it, the iron must be magnetised again by sending the current the opposite way round the iron, thereby giving the magnetising force a negative value, and this is precisely what an alternate current does; so that the first effects of this negative magnetising force are to neutralise or kill this residual magnetism, which is shown by that part of the curve from B to A. At a value of – 24 for H, the iron is entirely demagnetised, for the value of B is then brought down to zero. The iron is now again magnetised by the gradually increasing negative values of H, until the point C′ is reached, which is equal to C; upon decreasing the values of H, and so again demagnetising the iron, there is again residual magnetism left, because, when H is at zero, the value of B is 10,000, as shown by B′ in the curve C′ B′. The current, changing its direction a second time, brings values of H positive again, and so the rest of the curve B′ A′ is formed by the first values of H. The above forms a complete magnetic cycle of four operations, each cycle consisting of two magnetising and two demagnetising operations, as indicated by the closed

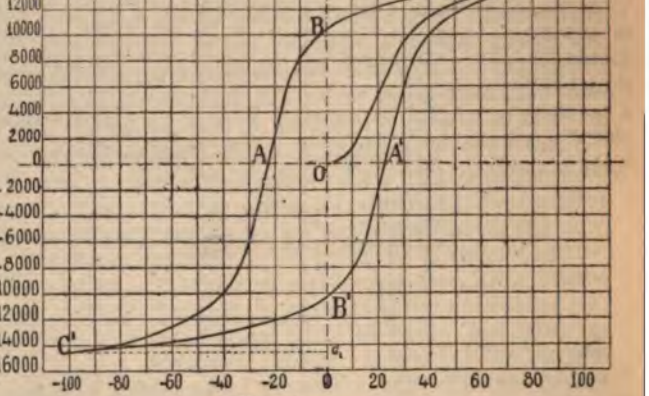

FIG. 14.

curve, C B A C′ B′ A′. On account of this residual magnetism, the magnetic induction, B, always lags behind the magnetising force, H, as can be seen in Fig. 14, for when H = 0, B = 10,000; the same when the current direction is changed. The whole of the area enclosed by the closed curve, C B A C′ B′ A′, measures the waste of energy that takes place due to this hysteresis; this wasted energy appears in the form of heat, consequently a bar of iron that is magnetised by an alternating current so that its magnetism is being constantly reversed, will rapidly heat up to a considerable degree. The greater the number of reversals per second, the greater will be the loss of energy in proportion, and the greater the magnetic induction the greater the loss also, but not in proportion—100 per second may be taken as a common practical number of cycles for an alternating current, and putting the magnetic induction, B, at 15,000, we may say that for soft wrought iron there is a loss of 1·5 watts for every cubic inch of metal, or about 16 h.p. for every ton of iron used. These figures will give some idea of the great amount of energy that is dissipated in heat in masses of iron when acted on by alternating currents. Although there are several other detrimental effects besides residual magnetism which are together classed under the name of hysteresis, yet residual magnetism is the most important factor. In very soft annealed iron this residual magnetism may reach as much as 90 per cent. of the maximum induction—that is, upon withdrawing the magnetising force, 90 per cent. remains behind, so that the bar is almost as strong a magnet as when the current was flowing round the magnetising coils. But this great amount will quickly disappear upon the slightest vibration of the iron, such as giving the metal a smart tap, or heating it: both the tapping and the heating cause the molecules to be put into an increased activity, and this destroys the magnetism. Application of great heat causes a permanent magnet to entirely lose its magnetism, and this stage is reached when the iron becomes red-hot, and upon cooling down the metal does not regain its magnetism.

(To be continued.)

LIQUID OXYGEN.

The phenomena presented by liquid oxygen promise to furnish science with additional data for the completion of chemical, electrical, and magnetic theory. Prof. Dewar, who has made special research into the properties of liquid gases, has already produced small quantities of liquified oxygen obtained under great pressure at very low temperatures, and has remarked the sky-blue colour and the considerable magnetic properties of this body. But its extremely low boiling point, 182deg. C. below zero, has hitherto prevented any appreciable quantity of oxygen remaining long in a liquid state, and the intense ebullition which occurs has rendered experiments on its magnetic and other properties difficult to accomplish. On Friday, however, before a large and distinguished audience, at the Royal Institution, Prof. Dewar kept, during the whole of his lecture, a globe the size of an egg filled with liquid oxygen in a tranquil state below its boiling point, evaporating slowly as water at ordinary temperatures. This result he accomplished by the discovery that by surrounding the vessel containing the liquid by an extremely high vacuum, the influx of heat-vibration from the outside air is reduced one-seventh, as is indicated by the amount of escape of gas; or by further precautions even to a still lower amount. The vacuum must be high in the extreme meaning of the term, for Prof. Dewar has produced vacua measurable not in millionths but in hundred-thousand-millionths of an atmosphere, and by means which exhaust a large vessel more quickly than the mercury-pump exhausts the smallest. The difference in temperature between the globe of liquid oxygen and the air of the theatre was not less than 210deg. C., yet the globe remained four-fifths full of liquid by reason of its vacuum jacket at the conclusion of the lecture.

The experiment leads to some interesting considerations as to the principle of radiation across interstellar space, as our own world has its "vacuum jacket." The crucial experiment would be an hermetically-sealed bulb of liquid oxygen, self-poised in the centre of a perfect vacuum—an experiment impossible under present conditions (unless the magnetic properties enabled the bulb to be so poised). There is always some connection between glass spheres and their support, as well as convection and conduction of heat at the evaporating surface.

The liquid oxygen so obtained becomes the means of further research in liquefaction of gases. Prof. Dewar showed that atmospheric air can be condensed into a liquid at ordinary pressure by the cold of liquid oxygen boiling under the air-pump. But liquid air itself can be produced by other means, and the cold of one superposed on the cold of the other may enable the final task of liquefying (and possibly solidifying) hydrogen to be eventually accomplished.

The essential difference between a liquid and a gas of identical composition was illustrated by the behaviour of atmospheric air. Air liquefies as a whole with the usual proportions of oxygen and nitrogen. But when liquid air is allowed to boil the nitrogen distils off first, showing no appreciable admixture of oxygen until half the liquid has evaporated. Liquid air behaves in the magnetic field and in the spectroscope like dilute oxygen, and the colour is simply a more watery blue.

The most interesting part of Prof. Dewar's researches from the electrical point of view, undertaken in conjunction with Prof. Fleming, could only be alluded to in the lecture. It is found that pure metals reduced to these abnormally low temperatures increase in conducting power, perfectly pure metals showing a conductivity increasing as the temperature falls in such a manner that all the temperature-curves if produced would pass through the zero of absolute temperature. Electricity would pass through a wire of pure metal in interstellar space absolutely without loss. But the smallest impurity or alloy destroys this condition of perfect conductivity. On the other hand, non-metallic bodies so cooled show a conductivity decreasing with the fall in temperature. These investigations await interpretation. Meanwhile, science is furnished with another test of purity of element. Nickel prepared in the ordinary way does not conform to the law, but nickel deposited by Mr. Mond's process, from its combination with carbon monoxide obeys this law perfectly. We do not yet know what an "element" is, but the experiments allow it to be stated that some at least of the chemical elements do behave in a manner totally distinct from compounds. At the low temperatures produced, chemical forces remain in abeyance, and oxygen becomes as inert as nitrogen. At a temperature that is conceivably possible to produce, all molecular motion ceases, and every gas becomes rigid. At −273deg. C., or absolute zero, hydrogen itself will become solid and all matter will become dead.

The Goldsmiths' Company have so far provided the funds for these extremely important experiments, and it is to be hoped that the research will not be abandoned for want of financial means until carried to the utmost logical conclusion.

While writing of these experiments, it may be mentioned that before the Académie des Sciences at Paris, on 25th ult., a paper was read on the magnetic effects of oxygen gas at diverse temperatures by M. P. Curie. The apparatus used and the curves obtained are given in *L'Electricien* for January 21. M. Curie finds that at each temperature the coefficient of magnetisation of oxygen is constant at whatever strength of field observed (200 to 1,350 C.G.S. units). He has also verified the fact that when varying the pressure from 5 to 20 atmospheres the coefficient of specific magnetisation does not vary appreciably. He obtains the result that k, the coefficient of specific magnetisation of oxygen gas, between 20 and 450deg. C., varies in inverse proportion of the absolute temperature. This result is regarded as very important as regards the theory of magnetism. Oxygen being a magnetic body of simple molecular formation, the study of its properties is likely to lead to clearer notions as regards magnetic phenomena generally. The coefficient magnetisation of air, X, considering only the oxygen it contains, can be calculated, says M. Curie, at one atmosphere by taking the formula $10^6 X_t = 2,760 \div T^2$, T being the absolute temperature. This formula can be used for any temperature for making the corrections necessary in magnetic determinations carried on in air (granting that air does not vary in composition with the temperature).

The results of French investigators are suggestive, and now that by Prof. Dewar's research it is possible to obtain tranquil liquid oxygen, we may expect to have some of the obscure points on the theory of magnetism satisfactorily settled, or, at least, a more widely embracing theory defined.

MALLEABLE CAST IRON FOR FIELD MAGNETS.

BY F. R. MARKHAM.

In these days of competition, when small economies have to be practised, dynamo manufacturers are naturally turning their attention to materials for field magnets which can be cast as nearly as possible to the required shape, in order to diminish the large amount of machining entailed by the use of wrought iron. Cast steel is, of course, being largely used; its merits and demerits are now pretty well understood, and tests of various samples of it have appeared in the technical papers.

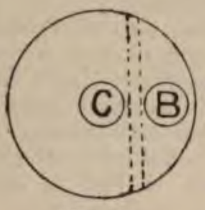

FIG. 1.

Malleable cast iron is also to some extent being used, though the writer does not remember having seen any tests of it published. As he has recently been making a number of tests on different materials, amongst others this malleable cast iron, he sends you some results in the hope that they may prove interesting to your readers. The samples tested were three in number, and were received in the form of bars 2in. in diameter and 18in. long; these were parted so as to allow of two rods, ½in. in diameter, being turned out of each, one from the centre, C, and one from the outside, B, of the original bar, as shown in Fig. 1. The rods were then tested in a Hopkinson yoke with a ballistic galvanometer, by the method of reversals.

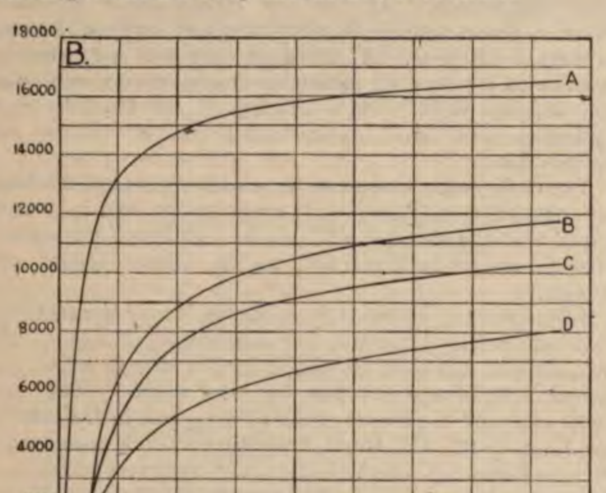

FIG. 2.

The results are plotted on Curves B and C, Fig. 2, being the average curve of the three samples cut from the outside of the bars; C the average curve of those cut from the centre. In each case the individual curves never varied more than a very little from the average curves given. Curves A (wrought iron cut from a magnet forging) and C (an ordinary cast iron) are also given for reference.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 26.

Mr. W. H. PREECE, F.R.S., President, in the chair.

The following is the list of members balloted for:

Member.—Vincent Sydney Allpress, 55, Victoria-street, Westminster, S.W.;

Associates.—Albert Anns, "Kenmore," Lennard-road, New Beckenham; Matthew Henry Barber, 10, Corporation-street, Manchester; John Richard Bradford, Telegraph Office, Brisbane; H. Davis, The National Telephone Company, Limited, Oxford-court, E.C.; William Douglas, 63, York-place, Edinburgh; Frederic Theodor Eggers, 122, Charing Cross-road, W.C.; Russell Forrester Ferguson, 2, Great Winchester-street, E.C.; Alexander William Frayne, Charters Towers, Queensland; Edward Leader Hanna, Rockhampton, Queensland; Charles Edward Jones, 1, Birch-street, Wolverhampton; Francis Lydall, Siemens Laboratory, King's College, W.C.; M. R. Margesson, 39, Victoria-street, Westminster, S.W.; W. C. Martin, 137, West Regent-street, Glasgow; Michael Charles Meaby, St. Luke's Vestry Hall, City-road, E.C.; Charles Wesley Sargeant, Blackall, Queensland; John Sinnott, the Post Office Relay Staff, Haverfordwest; Charles A Stevenson, M Inst.C.E., F.R.S.E, 84, George-street, Edinburgh; Philip Ibotson Unwin, Lordswood Lodge, Harborne, Birmingham; Alfred Watson, 3, Grange-road, Small Heath, Birmingham; George A. P. Weymouth, 62, Delafield-road, Charlton, Kent; F. A. S. Wormull, The National Telephone Company, Limited, Oxford-court, E C.

Students.—Alec Alfred Beadle, Belvedere, Kent; Walter Eynon, 57, Darenth-road Stamford Hill, N.; Gilbert Holt Green, 16, Shirlock-road, Gospel Oak, N.W.; Douglas Kerr Hall, Hill View, High Barnet; George Kemp, University College, London; William Murray Morrison, Birchwood, Inverness, N.B; Herbert Bryan Poynder, 8, Eliot-place, Blackheath.

After the formal business the President read his

INAUGURAL ADDRESS.

I.—TELEGRAPHY.

Having completed my fortieth year of continuous service in developing the practical applications of electricity for the use and convenience of man, it has appeared to me that I could not better repay the high compliment you have conferred on me by electing me, for the second time, to be your President than by surveying and criticising the growth of the various branches of electrical industry with which I have been more or less associated during this long period.

In 1852, when I commenced my engineering career in the office of Mr. Edwin Clark, member of the Institution of Civil Engineers, the electric telegraph was in its infancy—the needle system of Cooke and Wheatstone in England, the electromagnetic recorder of Morse in America, the sounder of Steinheil in Germany, and the semaphore of Breguet in France, were struggling into existence against adversity and ignorance. They were crude in their form, slow in their action, and uncertain in their working.

The acquisition of practical experience, the reforming tendency of inventive genius, the development of commercial businss, the wants of different countries, gradually eliminated the weak, encouraged the strong, and promoted novelty. The fittest survived, but even 40 years has not seen finality. We are improving and advancing as fast now as we ever were.

In 1852, the principal instrument used in England was the double-needle. It required two wires for its operation. Our offices were fitted with massive Greek temples, fashioned in wood, containing in their interiors the galvanometers and commutators by which the elements of language were to be transmitted instantaneously between London and Edinburgh and other towns. This wonderful structure, so much prized in its day, is now, like some antediluvian monster, discovered only in our museums; but its memory is dear to those who, like myself, struggled with its troubles, and who learnt most of what they know by mastering its whims and conquering its vagaries.

The semaphore has also been relegated to the museum, and the Morse recorder is gradually disappearing to the same refuge, but its struggles for existence is more prolonged and better maintained. The telegraphic tory who sees virtue in a tape, and believes in the greater accuracy of a record, still exists in large numbers in various parts of Europe; but he has disappeared from the United States of America and from England. The ear is more accurate than the eye, and more rapid in deciphering those fleeting signals that convey language.

The record, however, remains in Wheatstone's automatic apparatus and in Prof. Hughes's beautiful typewriter, which delivers the message to the receiver in clear, bold, Roman characters—an instrument that has weathered every storm, and is now the great international medium of communication between all European nations.

The peculiarity of the telegraph is its great cosmopolitan character. It unites all nations by one language, and connects them together by the same metallic nerves. It has broken down Chauvinistic doctrines and national prejudices. In England we care not whence invention springs; a new process or an evident improvement is as welcome from Timbuctoo as from St. Martin's-le-Grand.

The instrument that we have principally developed in England is the automatic fast-speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Ströh in 1866.

This has been my special pet, and with the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, all the ills that telegraphs are heir to have been routed, and the practical speed of working has been multiplied more than sixfold.

It has been one long continual contest between patient observation, inventive skill, careful experiment, and technical acquirement on the one hand, and resistance, electrostatic capacity, inertia (electromagnetic and mechanical), bad insulation, impure materials, imperfect workmanship, etc., on the other. But we have, step by step, won all along the line: 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible.

All these things have been done without recourse to the Patent Office. Dozens of improvements have been effected which in ordinary commercial life would have been patented and published, and received recognition. The absence of a patent has led to the belief in the absence of invention. An actual sixfold capacity for carrying messages is an answer to this supposition.

The Hughes typewriter has this year been successfully duplexed between London and the Continent, a problem which had hitherto baffled all attempts at a satisfactory solution.

The use of electromotors instead of weights on this instrument and on the automatic apparatus, and the extensive use of accmulators instead of primary batteries, may be mentioned, although time will not permit me to refer to a host of minor improvements which have been effected.

The results to which I have referred have not been attained without very special attention to questions of construction and maintenance of the wires, both aerial and submarine, and a very complete system of test is now applied both before and after every line is completed.

In the early days of telegraphic communication very rough and crude tests were applied, and the condition of the lines caused serious difficulties, but at the present day we must ascertain the purity of the metal employed, its mechanical strength, its electrical resistance and capacity, its insulation resistance, and the relationship between the latter and the conductor resistance, as well as its speed value.

The employment of copper as the conductor suspended on poles in place of iron, which was inaugurated at my instigation in 1884, by a very costly experiment between London and Newcastle, has had a material influence in increasing the speed of working and improving telegraphy.

This is due not only to its reduced resistance, but to the absence of electromagnetic inertia in a long, single, suspended copper wire. All our long important telegraphic circuits are now built with copper.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government Department. This has been entirely falsified. Telegraphy has been advanced in this country more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. Their engineers are looking to us to develop their inventions, and we have done so. They cannot always get them taken up in the States. Diplex, quadruplex, and multiplex telegraphy are importations from them, but they have been improved in our service by our own developments, and have now become the staple and the standard modes of working. No one has done more to effect this object than Mr. M. Cooper.

An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England. Few people are aware of the immense business done for the Press. The growth of Press messages is shown in the fact that 21,701,968 words paid for in 1871 have grown in 1891 to 600,409,000—an average of nearly 2,000,000 words per day.

When Mr. Gladstone spoke at Newcastle, at the National Liberal Federation, in 1891, 390,778 words were signalled to different parts of the country. This kind of business is not, however, confined to the Post Office. The Exchange Telegraph Company, which commenced operations in 1872, working under the license of the Postmaster-General, has in London over 800 instruments at work (120 being in newspaper offices), distributing a daily average of 3,381,134 words to various receiving instruments, adapted to the requirements of the respective services. The financial intelligence, for example, being transmitted over instruments furnished with type-wheels containing the various fractions most in use in Stock Exchange quotations. The latest form of this instrument prints at the rate of 40 words per minute. General and parliamentary intelligence are distributed to the clubs over column printers, and legal, sporting, and parliamentary news to newspapers on specially fast tape printers, capable of delivering, in the hands of skilled operators, 45 full words per minute to any number of subscribers simultaneously. The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day.

To return to the purely State telegraphy. Some idea of the growth of the general telegraphic business of the country may be gathered from the following statement, which gives the total number of messages paid for in each year:

1852	211,137
1869	6,830,000
Transfer took place in 1870.	
1882	31,345,861
1892	70,215,439

The monopoly of the Post Office is a mutual co-operative concern, in which every member of the community has an interest, and which everyone helps to maintain in efficiency and good working order by watchful supervision. It is not a mere commercial industry, maintained for the benefit of the few who have risked their capital in speculation. It is maintained for the general good of the community, and for the public service. Everyone can criticise and growl, and everyone does when he gets the chance, and would probably growl if he had not the chance. There is always joy in the soul of the editor when he discovers a fault in a Government official.

We public servants do not object. We rely on public criticism, and our sole object is to serve our masters, with a conscientious determination to do our duty to the best of our ability.

II.—SUBMARINE TELEGRAPHY.

In 1852 the only working cable was that laid between Dover and Calais by the Submarine Telegraph Company, under the auspices of Sir James Carmichael (one had been laid between Anglesea and Ireland, but failed on the second day). Those between Dover and Ostend, Orfordness and Holland, and between Scotland and the North of Ireland followed in 1853; and several miles of the first-named cable have remained down ever since, and form parts of the present cable between Ramsgate and Ostend.

In those early days I was much engaged in testing, laying, and maintaining submarine cables, and in 1858-62 was engineer to the Channel Islands Telegraph Company, whose cable between Portland and Alderney gave such immense trouble, from the nature of the ground near either end, that it had eventually to be abandoned, because the business did not pay for the cost of maintenance. A new cable was laid in 1870 over a different and better route, and now, 1893, the islands maintain cables of three conductors.

The growth of submarine cables about the world is extraordinary. The total mileage, which in 1852 was 87 nautical miles (nauts),[*] now reaches a total of 139,594 nauts, of which 14,479 nauts belong to various Government administrations.

The experience of early days has taught us how essential it is to have accurate surveys of the bottoms to be crossed before trusting cables to their tender mercies; and thus geography and biology have been immensely benefited by the work of the electrical engineer.

By the end of 1855 the North American lines had extended to Newfoundland, while those in Europe reached the West of Ireland, and a scheme was started to connect, by a cable across the Atlantic, the New World and the Old. Cyrus Field, as vice-president of the New York and Newfoundland Telegraph Company, obtained the sole right to land cables in Newfoundland, Nova Scotia, Prince Edward's Island, and the State of Maine, and the Atlantic Telegraph Company was formed by him to make and lay the cable.

The first attempt was made in August, 1857, by H M.S. "Agamemnon," and the U.S. frigate "Niagara"; but after paying out about 380 miles from the Valentia end the cable broke and the expedition was abandoned until 1858, when the same two ships, this time commencing in mid-Atlantic and steaming in opposite directions, succeeded in laying the cable; but after 732 messages had been sent through it again failed, in October, 1858. Several unsuccessful attempts were made to pick it up, and the Atlantic scheme remained in abeyance until 1865, when a heavier cable was successfully laid, being the commencement of the present Anglo-American Company's system, with its four cables now working across the Atlantic. There are now 11 cables bridging the Atlantic Ocean.

Between this country and the Continent all the cables (with the exception of those to Norway, those to Spain, and those forming the connections with the Eastern Telegraph Company's system) now belong to the respective Government administrations, and are all maintained by them.

The British Post Office owns and maintains those to Holland and one of those to Germany, while those to Belgium and France containing 37 wires, are joint property, but maintained by the British Post Office.

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By far the greatest cable corporation in the world is the Eastern Telegraph Company, whose system of 25,376 miles stretches from Cornwall to Bombay, connects the northern and southern shores of the Mediterranean with Malta, and joins up the various other islands of the Mediterranean and the Levant. This company, in conjunction with the Eastern Extension and the Eastern and South African Companies, also gains access to Australia and New Zealand on the one hand, and to the Cape of Good Hope on the other, the combined mileage reaching a total of no less than 47,151. This enormous system has all grown up within, practically, the last 23 years.

The form of cable has practically remained unaltered since the original Calais cable was laid in 1851. Various sizes of core and armour, and various modes of protection from decay, have been used to suit different routes, but the cable of to-day may be said to be typically the same as that used in the English Channel in 1851, and in the Atlantic in 1865.

(To be continued.)

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[*] It is a very general custom to spell this abbreviated term for a nautical mile knot, but a knot is a velocity, not a length. It is a nautical mile per hour.

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STORAGE—HEAT OR ELECTRICAL ENERGY.

Prof. Unwin, in his second Howard lecture at the Society of Arts last Friday, described more fully the proposed apparatus designed by Mr. Druitt Halpin for heat storage, and the bearing such storage has upon central-station working, as well as its bearing in certain cases where much heat is generated, and under existing circumstances more or less lost. We briefly referred in our last issue to the apparatus, but a few more details will make the matter clearer. Mr. Halpin suggests the use of cylindrical thermal tanks of 8ft. diameter and 30ft. long, each of which would have a capacity of 84,000lb. of heated water. Restricting our view for simplicity to a single thermal tank and its accompanying boiler. The latter is so connected with the former as to allow of a free circulation of water with the boiler always full. Steam is taken from the thermal tanks. Incidentally, it may be noticed that the depreciation of the tanks will be smaller than that of boilers, because the deterioration through contact with fire does not occur. It is proposed that the water in the thermal tanks be heated at full charge to 406deg. F, corresponding to a steam pressure of 165lb. absolute. The engines would work at 130lb. pressure, or 347deg. F. absolute, so that the range of temperature available is 406deg. − 347deg. = 59deg. Allowing for the change in the specific heat of water at these temperatures, each pound of water, whilst its temperature fell through 59deg., would give off 61 thermal units. The total heat of steam at 130lb. pressure is 868·8 heat units. Under the above conditions, if each pound of water gives off 61 units, the number of pounds of water to give 868·8 will be $\frac{868 \cdot 8}{61} = 14 \cdot 24$. However, leaving a margin for losses, we may say that 16lb. of water will be required to generate 1lb. of steam. As we have in each tank 84,000lb. of water, $\frac{84,000}{16} = 5,250$ is the number of pounds of steam that can be obtained at 130lb. pressure. Taking, then, that each tank under the assumed conditions will provide as required in large or small quantities a maximum of 5,250lb. of steam, what will that do for our engines? Prof. Unwin estimated that condensing engines would take 18lb. of steam per effective horse-power hour, and non-condensing engines would take 25lb. Hence such a thermal tank would, in the first case, supply $\frac{5,250}{18}$, or nearly 291 effective horse-power hours, while in the second case the supply would be $\frac{5,250}{25}$, or 210 effective horse-power hours. It will be well to call attention here to one remark of Prof. Unwin's. The lecturer made a reservation to the effect that, considering one boiler and one tank only, he had no difficulty in agreeing that the thermal storage suggestion would do all that was said it would do, but when a battery of boilers and storage tanks were used, there might be difficulties which it was not easy to foresee, but which might play an important part in the matter. Thus steam might be generated in a part of the battery where it was not wanted, yet nothing but a trial would prove or disprove the practicability of the scheme. As regards cost, some detailed estimates were given, but it will be sufficient to say that the estimate for a 2,000-h.p. central station, which would consist of three boilers and 24 thermal tanks, would be about £5,000 more than if equipped in the present manner. If, however, there was a saving of half-a-pound of coal per effective horse-power hour, this saving alone would pay a good percentage on the extra cost.

Thus far with central stations. It must again be emphasised that Mr. Druitt Halpin's plan only proposes a saving on the boiler losses; it has no effect upon the engine or other losses. The value of this saving for central-station work is not yet proved, but in other cases the economy is assured if the batteries of thermal tanks are made practicable. An intermittent demand upon such tanks hardly affects their economy. It becomes merely a question of manipulation of the reducing valve. Prof. Unwin referred to two directions in which considerable economy might be effected. A large number of towns are now employing or erecting refuse destructors. These destructors are kept burning night and day, year in and year out. Several investigators have given estimates of the heat waste. As our readers know, Prof. G. Forbes has paid special attention to this subject, and Mr. G. Watson has published elaborate investigations. Mr. Bennett, the borough engineer at Southampton, has, we believe, had destructors burning continuously for seven years, and has, to a large extent, utilised the waste heat in generating steam for driving dynamos and other machines. Usually, ordinary machinery runs through the day only, and so the heat generated while not working is lost. If the ordinary machinery is supplemented by dynamo-driving, a greater part of the heat is utilised, but if Mr. Halpin's plan was adopted, all, or nearly all, the heat might be economically used. In some instances, according to Prof. Forbes, the heat now wasted in the use of refuse destructors would almost or quite suffice for the artificial lighting of the district supplying the refuse. We cannot go quite so far as this for a general assertion, because the refuse of one district differs enormously from the refuse of another, and again, the refuse differs greatly from day to day. Still, there is no doubt this scheme of Mr. Halpin's will receive, as it deserves, the careful attention of every municipal engineer, and will prove an extremely valuable adjunct to the use of destructors. There is also another direction in which it may prove of considerable importance. In all gasworks an enormous amount of heat is generated and wasted. It will be the duty of gas managers to investigate this new departure, and possibly they may see their way to supplement the distribution of gas by the distribution also of electricity. If our memory serves us correctly, Prof. Unwin estimated that at least 30,000 effective horse-power were continuously lost by the loss of this heat from gasworks. This loss is well worth the saving, and if gas managers are impressed with the value of Mr. Halpin's apparatus they may find it a handy weapon wherewith to stave off competition.

CITY AND SOUTH LONDON.

Every electrical engineer is interested in the history of this line—at least, interested till the time comes when a fair dividend, say, 5 per cent., shall be assured to the shareholders who have taken a big risk. The report of the directors for the past half-year is before us, and shows moderate, if not rapid, progress. We cannot give all the tabulated figures of the report; those of the revenue and general balance-sheet will be found elsewhere. The remainder must be given shortly. The authorised and sanctioned capital is £1,025,000. Of this, £686,680 has been received on stock, shares, and preference shares. There has been raised on loans and debenture stock £168,900. Of sanctioned capital there remains £167,400 to be raised—that is, out of the total £1,025,000 the company has had £857,580, and may raise £167,400 more. For this, out of the authorised 4 miles 11 chains a length of 3 miles 12 chains of line have been constructed. During the half-year a mileage of 214,417 miles has been run at a cost for locomotive and generating power of £6,348. 6s. 8d., that is just a fraction over sevenpence per mile. The traffic expenses are a little less, £6,052. 7s. 11d., or a fraction under sevenpence per mile. The maintenance of permanent way and works cost only £389. 18s. 9d., and of carriages £416. 13s. 10d.—small amounts, as might be expected. The total revenue from 3,217,602 passengers and 289 season tickets was £22,017. 10s. 3d. Other receipts bring the total revenue up to £22,652. 13s. 11d., and this was earned at a cost of £15,389. 17s. 2d., leaving a favourable balance of £7,262. 16s. 9d. This—with £983. 2s. 2d. over from last half-year, and interest, £58. 13s. 3d.—gives £8,304. 12s. 2d. to be dealt with. Of this, debentures take £4,008. 5s. 10d.; debenture stock, £250. 13s. 4d.; preference shares, £1,254. 10s. 9d., and giving ordinary shares ⅝ per cent. per annum, £1,968. 19s.—leaving £822. 7s. 3d. to carry forward. Now, ⅝ per cent. per annum is no great thing; but it recognises the existence of ordinary shareholders. According to these figures, before a 5 per cent. can be given to the ordinary shareholders, the half-yearly balance must show £15,750 available for this purpose.

We have said above that the train mileage this half-year is 214,417 miles, and that is an increase on the corresponding half-year last year of 25,751 miles, the mileage then being 188,666. The revenue for the mileage run in the corresponding period last year was at the rate of about 2s. 1⅕d. per mile, while that of this last half-year is a little less, being not quite 2s. 0½d. per mile. These, we think, are the salient figures put forward in the balance-sheet. Of course great things are expected in the way of improvement when the whole of the extensions have been completed. It is, however, impossible to foretell what the result will be.

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

XI.

(*Continued from page 535, Vol. X.*)

RESISTANCE, *continued.*

Slide Resistance Coils.—Another and very convenient method of measuring Resistances is by means of what are known as Thomson and Varley's Slide Resistance Coils, designed by Lord Kelvin and Mr. C. F. Varley.

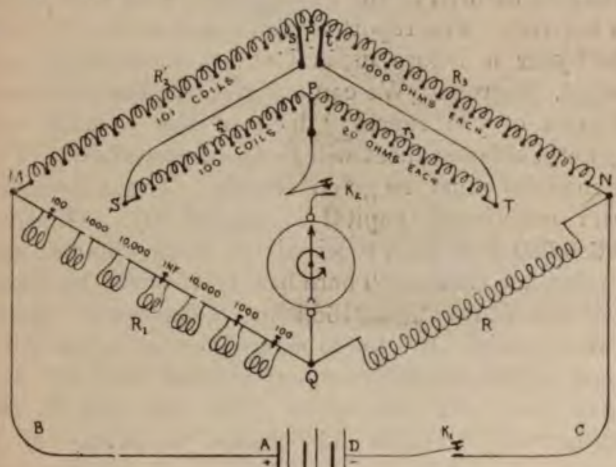

FIG. 27.—Diagram showing Principle of Thomson and Varley's Slide Resistance Coils.

With this method, just as in the original Metre Bridge, the known variable resistance R is kept constant during a measurement, and the adjustment is made by altering the position of P, the point which divides the whole resistance in the slide or slides into the two parts R_2 and R_3. These two parts virtually constitute the arms or ratios of the bridge, just as did the two portions of the long wire on either side of the contact-maker in the original Metre Bridge. Thus the primary idea of this method of measurement is simply the original Metre Bridge with a series of fixed ratios taking the place of the long high-resistance wire. For convenience sake these resistances are connected up to a series of pins arranged round the circumference of a circle, and contact is established by means of a radial arm pivoted at the centre.

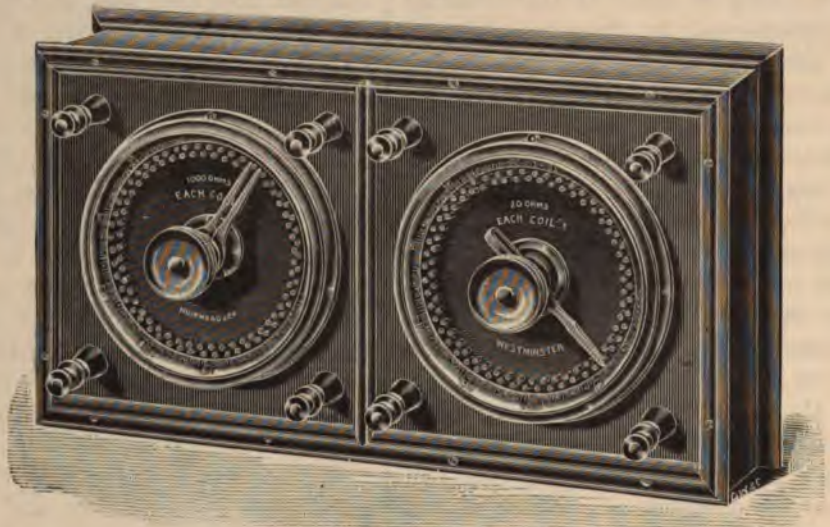

FIG. 29.—Thomson and Varley's Slide Resistance Coils. Muirhead's Pattern.

The Thomson and Varley combination consists of two separate slides, one or both of which can be used for measuring resistances by this method. These are known respectively as the Single-arm or Vernier Dial, and the Double-arm or High-resistance Dial.

The Single-arm Dial, sometimes termed the Vernier Dial on account of its acting as a vernier to the other when the two are used conjointly, contains 100 coils of 20 ohms each, connected up to a series of pins, 101 in number, numbered from 0 up to 100 and arranged round a circle as in Swinburne's instrument, described in the last article. The two terminals, S and T, Fig. 28, at the left-hand side of this dial are connected as shown to the pins (S) and (T) at the two extremities of the series by thick underboard copper strips; and the pivoted arm, the outer end (P) of which can be made to rest on any of the pins in the series, has its pivot similarly connected to the terminal P at the top left-hand corner of the dial.

The Double-arm or High-resistance Dial contains 101 coils of 1,000 ohms each, arranged and connected to a series of pins exactly as in the single-arm dial, and the two pins at the extremities, Nos. 0 and 101, are connected to the two terminals, M and N, Fig. 28, at the left-hand side of the dial, also as in the other case. Instead of having a single arm pivoted in the centre, this dial is provided with two parallel arms electrically insulated from each other, but rigidly connected together so that they rotate on their common pivot as if they were one piece. Their two extremities are fixed at such a distance apart that they always span a pair of coils, as shown in Figs. 27 to 30. The two arms are electrically connected by thick underboard copper strips to the two terminals *s* and *t*, at the right-hand side of the dial, as shown in the diagram, Fig. 28. The one arm can be made to rest on any of the 100 pins from 0 to 99, while the other always indicates two more, so that its range is from 2 to 101.

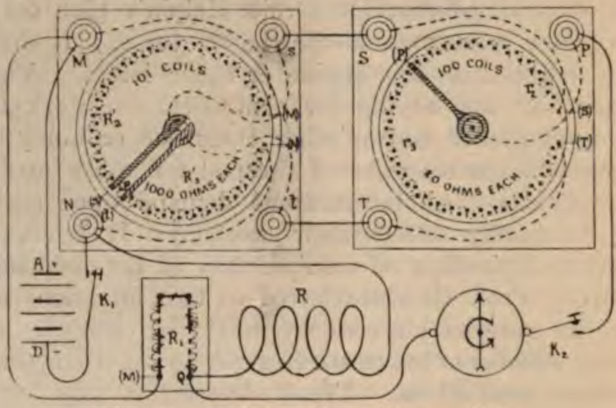

FIG. 28.—Method of Connecting up Coils.

Either of the two dials can be used singly or the two may be used in conjunction for measuring resistances on the Wheatstone's Bridge principle. When the single-arm dial is used alone, the sum of the two ratios R_2 and R_3 is equal to 2,000 ohms, and the one can be increased while the other is diminished by steps of 20 ohms. When the double-arm dial is used alone, only one of the two arms is in operation at the time, the electrical connections to the terminal of the other not being made. In this case $R_2 + R_3$ is equal to 101,000 ohms, and the one is increased while the other is diminished by steps of 1,000 ohms. Thus only comparatively rough measurements can be made in this way, using either of the two dials alone. When both of the dials are used in conjunction, the single-arm dial shunts half the current passing through the other, and fulfils the part of a vernier or fine adjustment to the other. With this arrangement $R_2 + R_3$ is equivalent to 100,000 ohms, and the one can be increased while the other is diminished by steps of 10 ohms, or one ten-thousandth of the whole.

The method of using the two slides conjointly, and the principles underlying it, are illustrated diagrammatically in Fig. 27; and the manner in which the slides are connected up for measuring an unknown resistance, as well as the underboard connections, are shown in Fig. 28. Examples of the instruments themselves are shown in Figs. 29 and 30.*

From Fig. 27 it will be seen that the single-arm slide, which is represented in the diagram by the part S P T, is connected up so as to form a shunt to the portion *s t* lying between the arms of the double-arm slide M *s t* M. But as these two resistances S T and *s t* are exactly equal, being each 2,000 ohms, the current is equally divided between the two paths, so that the introduction of the single-arm slide is just equivalent to reducing the virtual resistance between the points *s* and *t* to one-half, or 1,000 ohms. Thus the combined resistance of the two slides when coupled up in this way is just equal to 100,000 ohms, instead of 101,000 ohms when the double-arm slide was used alone.

After the double-arm slide has been adjusted so that the required point lies somewhere between *s* and *t*, and the single arm of the other slide has been brought to such a position on its dial that the galvanometer indicates no deflection, showing that the potential at P is just equal to that at Q, the virtual values of the two ratios R_2 and R_3 will be obtained as follows:

> Let *p* be a point which divides the resistance of *s t* so that $sp = SP$, and $pt = PT$;
>
> Then the potential at *p* will be the same as that at P and at Q;
>
> And R_2 is equal to the resistance of Ms + the combined resistance of *s p* and S P.
>
> But *s p* and S P being equal, their combined resistance in parallel is equal to the half of either, equal to $\frac{1}{2}$ S P.

$$\therefore \qquad R_2 = Ms + \tfrac{1}{2}SP$$

$$\text{similarly} \qquad R_3 = tN + \tfrac{1}{2}PT$$

$$= 100{,}000 - R_2.$$

Thus it will be seen that in reading off the value of R_2, the half of S P, the reading of the single-arm dial, must be taken; but as ST, the total resistance of the dial, consists of 2,000 ohms subdivided into 100 equal parts, the pointer is read direct, and each of these divisions is taken as 10 ohms instead of 20. Thus the value of R_2 is read off in five digits direct from the two slides. The first two are obtained from the lower-value arm of the double-arm dial, and the next two from the pointer of the single-arm dial, adding a 0 for the last digit. R_3 is obtained by subtracting R_2 from 100,000.

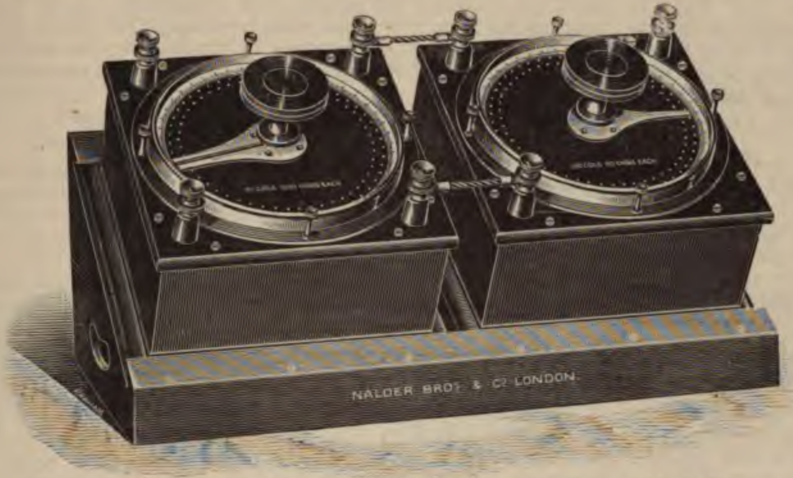

FIG. 30.—Thomson and Varley's Slide Resistance Coils. Nalder's Pattern.

Thus with the arrangement shown in Figs. 27 and 28, R_1 being the known variable resistance, and R_2 and R_3 the two ratios, the value of an unknown resistance R being measured, will be found in the same way as before, thus:

$$R = R_1 \times \frac{R_3}{R_2},$$

$$= R_1 \times \frac{100{,}000 - R_2}{R_2}.$$

(To be continued.)

AN IDEAL CENTRAL POWER STATION.*

BY C. J. FIELD, E. J. COOK, AND F. BOURNE.

(Continued from page 74.)

ENGINES.

Engine manufacturers and designers to-day are devoting their best time and attention to the development of a type of engine best adapted for electrical power work. We find, therefore, more progress being made this year and still more promise for the year to come than has been made in a number of years on this work. The old high-speed engine has done well, and the Corliss engine too. Present work and requirements seem to tend to a type of engine combining, it might be said, the good features of both, filling a middle ground, and adapting itself more fully to the demands and requirements of large central station work with direct connection. Engines meeting these requirements are now being built and manufactured by such firms as the Lake Erie Engineering Works, Dickson Manufacturing Company, Cramp and Sons' Ship and Engine-Building Company, Pennsylvania Ironworks Company, M'Intosh and Seymour, E. P. Allis, and other builders. We have tried to indicate the requirements of such an engine in the following specifications:

ENGINE SPECIFICATIONS.

Duty.—Electric railway and power work. All parts extra heavy.

Type.—Vertical, three crank, triple condensing.

Power.—Ability to develop for short periods of time a power of at least 50 per cent. above its rated capacity without dropping off in speed of revolution.

Regulation.—Regulation effected by means of a shaft governor acting on the valves of high-pressure cylinder alone. Governor designed to cut off all lead of steam-valves when practically all load is thrown off the engine. The momentary variation of speed of revolution (*i.e.*, the variation that would take place in three to five seconds) not to exceed $2\frac{1}{2}$ per cent. when one-half the rated load of the engine is thrown suddenly on or off, indicated by means of a tachometer belted direct to the engine-shaft.

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* The instrument shown in Fig. 29 was made at the works of Dr. Muirhead; and that in Fig. 30, at the works of Messrs. Nalder Brothers.

* Paper read before the Chicago Electric Club, Dec. 19, 1892.

Economy.—Economy, with condenser under average economical load, to be not more than 14lb. of steam per indicated horse-power per hour, with 150lb. initial steam pressure and 26in. vacuum. This assumes that the steam is not to exceed 2½ per cent. of moisture, and the first cylinder steam-jacketed with full boiler pressure.

Valves.—To have four valves to each cylinder. These steam and exhaust valves to be independent, with exhaust valves moved by separate gear. Valves on high-pressure cylinder to be either of the piston type or flat valve, balanced, with pressure plate. Valves on intermediate pressure and low-pressure cylinders to be of flat type, either four-ported, partially balanced gridiron or Corliss type.

Clearances.—Clearances not to exceed 8 per cent. in the high-pressure cylinder and 3 per cent. in the intermediate and low-pressure cylinders. Cylinders to be protected by non-conducting covering, such as magnesia or asbestos and steel or cast-iron jackets for finish. Cylinders in receivers to be protected by means of relief-valves.

Frames.—To be cast-iron box girder type " A " frame.

Shaft.—Of best forged steel with built-up cranks and counter-balanced in one piece.

Bearings.—All main bearing surfaces, such as shaft bearings, slides, etc., should be water-jacketed.

Gallery.—Engine to be furnished with one or more galleries from which it can be operated as well as from the floor, and offering easy and safe means of access for lubrication and inspection.

Lubrication.—Engine to be provided with either oil or grease lubricating apparatus, such that it can be lubricated as thoroughly when in motion as when at rest. Each cylinder to be provided with sight-feed lubricators as well as oil-pumps, and the entire engine, if oil is used for lubrication, to be fitted with sight-feed lubricators. In the case of grease lubrication provision is to be made to allow any part to be lubricated individually, as any system of grease distribution from a common centre involves the possibility of stoppage of tubes with dirt or foreign substances.

Fly or Belt Wheels.—The engine should be provided with intermediate wheels between the cylinders where possible, so as to bring the shaft as near the condition of uniform load as possible. Allow 48lb. per indicated horse-power in case of electric lighting, and 70lb. in electric railway and power work for weight of flywheels. Rim of wheels, on a basis of 5,000ft. velocity of the rim per minute. Piston speed, 650ft. per minute.

Rotative Speed.—A mean figure between a high, or what is commonly understood by high and low speed—say, 120 revolutions per minute on a 750-h.p. triple.

Remarks.—The power the engine should develop when connected direct to an electric generator should be determined by the capacity of the generator first, and also its capacity for overload. The engine should have an ultimate capacity approximating that of the generator.

Experience has proved that an engine of large power can be regulated closely as regards speed of regulation, by means of a shaft governor acting directly on a properly-designed valve and gear on the high-pressure cylinder alone of a triple-expansion engine. The governor should have a "gravity balance" in case the steam-valve on the high-pressure cylinder is placed in such a position that it is free to move vertically, as is generally the case in this type of engine. The governor should also have a centrifugal or "running balance" when the engine is in motion. As mentioned in specifications, the governor should be designed to cut off all lead of the steam-valves operated by the governor, so that when practically all load is thrown off the engine, the governor will admit absolutely no steam to the high-pressure cylinder, thus compelling the engine to decrease in speed by having only the remaining speed in the first and second cylinders to draw on, instead of the amount that would be admitted by the lead of the high-pressure cylinder valves, as usually done to-day.

The specifications for valves in the engine described follows logically when the regulation of the engine is obtained by means of a shaft governor acting directly on the high-pressure steam-valves without the intervention of any intermediate gearing to assist the centrifugal force of the governor, thus depriving it of its sensitiveness in changes of speed. The piston type of valve is open to the objection of leakage, but inasmuch as any leakage would be expanded in the next two cylinders of a triple, the simplicity of the valve and its action under high-pressure steam tends to balance this argument. It is essential to have the valve balanced on account of the high steam pressures used in this cylinder. The valves on the intermediate and low-pressure cylinders, as already specified, would give a practically perfect steam distribution when moved by the eccentrics, and the engine can then be adjusted to the service required, be it condensing or non-condensing.

One of the most vital points of an engine for electric service is that of main bearings. They should have a surface velocity of not exceeding 350ft. per minute, with a mean bearing pressure per square inch of projected area of journal of not more than 80lb. This is considerably within the safe limit of cool performance and easy operation. If the bearings are designed in this way, it would admit the use of grease on all the main wearing surface, which in a large type of engine for this class of work we think advisable.

In regard to the location of fly or belt wheels, we said in the specification that the engine should be only with intermediate wheels between the cylinders, so as to bring the shaft within the condition of practically uniformly loaded beam. This will prevent excessive wear on any one main bearing of the shaft, and in that way allow it to become other than a straight line.

In regard to rotative speed it is a mutual condition between the engine and generator, and is too often determined by financial considerations. The faster speeds permit less cylinder condensation in the engine, but require a greater amount of care in the engine-room. The tendency to change among large engines of the type for which we are furnishing specifications is toward the medium rotative speed.

Boilers.

After the engines, one of the next most important factors of a power station is a good type of boiler. There may be said to boilers and boilers—many types of them; but if we look carefully over the field we can in general bring them down, as far as concerns a power station of this kind, to three types or classes: First, the plain horizontal return tubular boiler, which has probably been more largely used in power-station and mercantile work than all the other boilers combined, and where there is ample space and a working pressure not exceeding 120lb. or 125lb. is required this type of boiler probably more fully meets general requirements than any other. Under the second head comes in the sectional or water-tube type of boiler as manufactured by Babcock and Wilcox and many other firms in the same line. This sectional water-tube type of boiler has been more extensively used, probably, than any other where high pressures were required, and it has in general cases met the requirements of this practice. We found, however, in some particular parts of our work, especially in power work where the load is subjected to violent fluctuations, that this sectional type of boiler lacks steam-room capacity to stand the violent fluctuations of load. This has caused engineers to look around for some other boiler which would combine the advantages of the horizontal return tubular and of the sectional. Without experimenting too much it seemed, on looking over the field, that the boiler which had been so largely developed for marine practice, as the internally-fired marine type of boiler, offers the best solution of the difficulty with some modifications and changes. We therefore classify this as the third style of boiler adapted for this kind of work and have used it in this station. Its advantages in development for high pressures have been demonstrated by long experience, also for economy of space occupied, economy in operation and good steaming capacity. Such type of boiler is described in the following specifications:

Boiler Specifications.

Type.—Internally fixed, direct fire tube marine boiler.

Pressure.—To be tight under 160lb. working pressure, and tested to 210lb. hydrostatic.

Capacity.—To evaporate 3lb. water from 100deg. and 70lb. pressure (M. E. unit) per square foot of heating surface; in other words, 10 square feet of heating surface per horse-power.

Economy.—To evaporate 9lb. of water from 120deg. F. at temperature corresponding to 160 steam pressure per pound of good Scranton anthracite pea coal when developing its rated capacity.

Quality of Steam.—The steam furnished by boiler when developing its rated capacity shall not exceed 2½ per cent. of moisture as determined by calorimeter

Furnaces.—To be of either the corrugated or Adamson type, having a common combustion chamber.

Riveting.—Longitudinal seams of shell to be butt-jointed and double butt strapped and triple riveted each side of butt. Circumferential seams to be double riveted. Flanges and heads to be single riveted. All holes to be drilled when sheets are in position for riveting.

Staying.—Boiler to be stayed in the most approved manner to withstand 160lb. working pressure. Strains on welded braces must not exceed 6,000lb. per square inch section. Solid stays must not have strains to exceed 9,000lb. per square inch of section. All stays, braces, and rivets to be of the best double-refined iron.

Manholes and Handholes.—Each boiler to have at least four manholes to facilitate cleaning, as well as a sufficient number of handholes for the same purpose.

Plates.—All plates to be the best marine steel of 60,000lb. tensile strength.

Fronts.—Each boiler to be supplied with neatly-designed furnace fronts and cast-iron bridge walls.

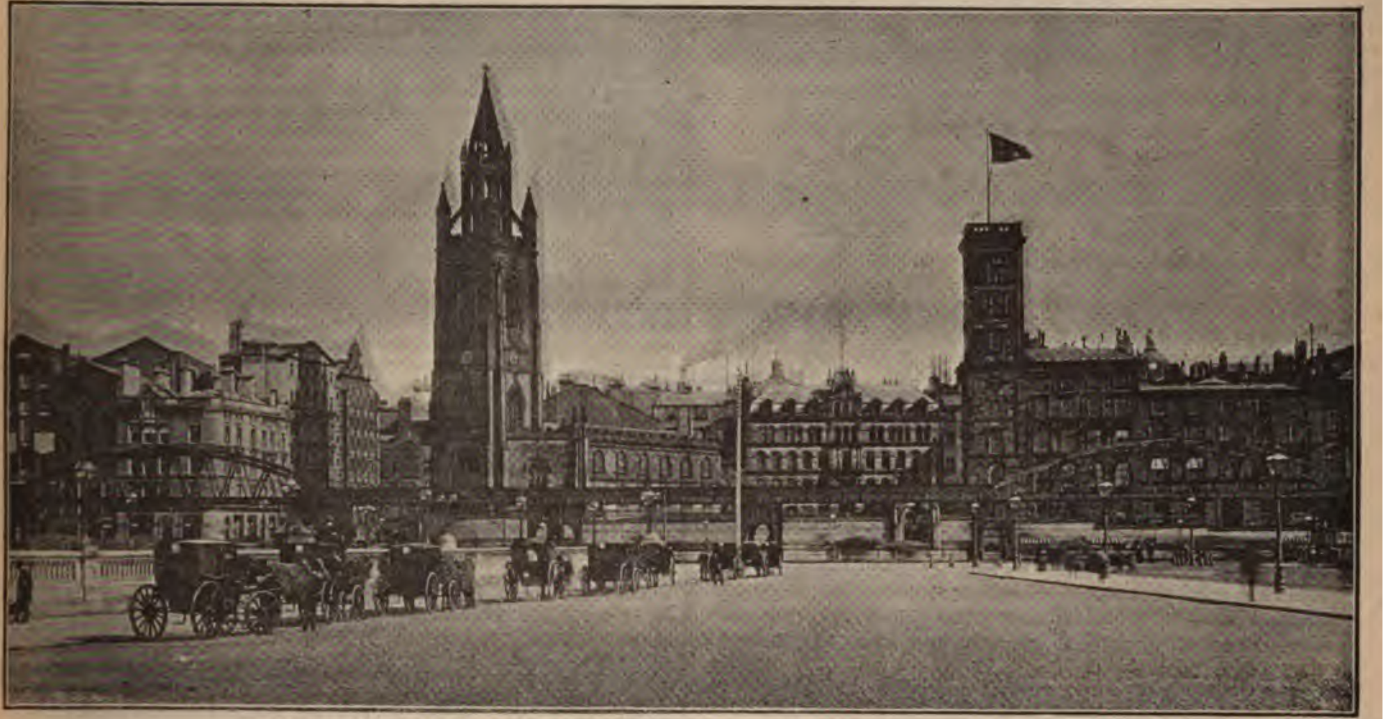
Fixtures.—Each boiler to be supplied with necessary supporting lugs or saddles, one set of grate-bars for each furnace, all necessary dampers, flue and cleaning doors and frames.

(To be continued.)

THE LIVERPOOL OVERHEAD RAILWAY.

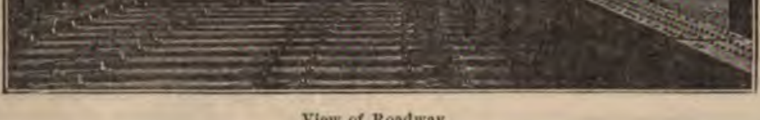
(Continued from page 65.)

In continuing the detailed description, begun last week, of the ironwork erection upon which are intended to run the electric cars for this new system, some notice must be taken of the arched flooring that has been adopted for the girders constituting the immediate substructure of the line.



Electric Railway in Front of Pierhead and St. Nicholas Church.

The rails being double throughout—the rail centres of each pair measuring 4ft. 10¾in. apart—a clear space of at least 22ft. in width becomes necessary between the longitudinal or side girders, and the flooring is built up, therefore, of iron plates measuring on the flat from 22ft. to 27ft. long by 46in. wide, the thickness being $\frac{5}{16}$in. Each plate is bent to an arched shape, and joined to the next by means of a T-iron 6in. by 3½in. by $\frac{7}{16}$in., and corresponding in length with the plates, one member of the T-iron being placed between the bottom edges of the two adjacent curved plates, and the three thicknesses then riveted up together. The arched flooring thus built up is riveted along the ends of the plates to the inner sides of the longitudinal girders by means of angle-irons shaped to the curve of the arch, and measuring 3in. by 3in. by ½in. thick. The flooring is sloped very slightly towards one side, so that any water accumulating from rainfall may drain away, spouts being provided for the purpose. The spandrels between the individual arches—on their upper surface—are filled to a slight depth with asphalte, so that the whole flooring is practically watertight. As a matter of detail, it is interesting to note that all the rivet holes in this flooring have been drilled, special machinery being employed for the purpose, capable of drilling the entire number of 192 holes in each plate in about 15 minutes.

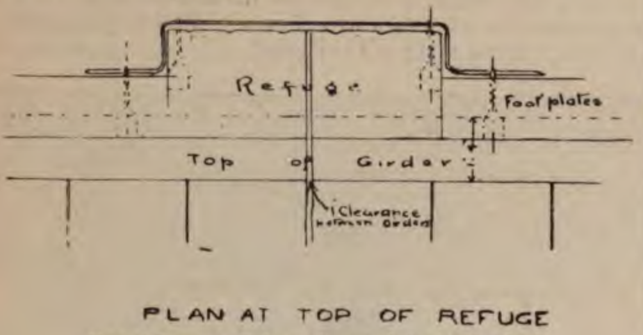


View of Roadway.

Upon the crown of each arch in this flooring are riveted iron cleats at suitable distances for holding the longitudinal timbers, upon which are spiked the flat-bottomed line rails. The outside cleat for each pair of rails is placed square with the arch, but the inner one is riveted on at an angle so as to give plenty of holding power to the wooden wedge or key that secures the sleeper.

The strength of this type of flooring thus employed for the new line appears to be on a level with its simplicity of design and construction. With distributed load, its breaking weight is stated to be 50·7 tons per section; though, as a matter of fact, a test of three sections joined together showed an ultimate breaking weight of 163 tons with a deflection of 10in. A safe load for the average span employed—22ft.—may be taken as about 4·6cwt. per square foot with distributed weights. Since each train, when fully loaded, has a gross weight of not more than 40 tons distributed over 16 wheels—the total length of wheelbase being at least 80ft.—there would appear to be a factor of safety large enough for all practical purposes so far as the strength of flooring in the superstructure is concerned.

The only remaining details to be given with reference to the ironwork of this line are a few particulars of hand-railing and foot-plates, etc., erected along the top of the girders for the use and convenience of permanent-way men. Iron stanchions, 1½in. by 1in. at base, sloping to 1¼in. by ¾in. at the top, are riveted at average intervals of 5ft. to the top (outside) of the longitudinal side girders, the bases of course being flattened out for the purpose. Three continuous rows of railing pass through these stanchions, one above the other, at various heights. The top rail is formed of 1¼in. iron gas-tube, the lower two of 1in. tube.

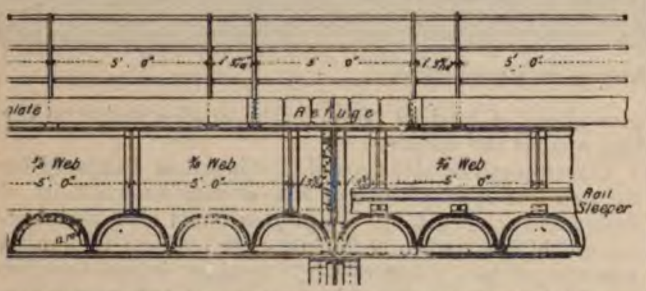


Plan of Recess or Refuge, above each Standard Column.

Over the top of each standard or column that supports the line is built a recess or refuge, giving a clear space of 5ft. 7in. from the innermost line rail to the outer railing. Curve foot-plates, $\frac{3}{16}$in. thick, are riveted to the top of the girders along with the stanchions.

The details thus given are not perhaps absolutely descriptive of each and every portion of the line, but may be considered exact as regards the greater part of it, which, as already stated, is found in spans and standards practically alike in all essential particulars.

There are several features of this overhead railway which deserve special notice and attention from a civil engineer's point of view. Prominent amongst these may be mentioned the double-decked swingbridge over the seaward entrance to the Stanley Dock, and the "tilting" bridges at landward entrances to the docks, where heavy and bulky goods, such as boilers, etc., are often drawn through.



Sectional Elevation of Superstructure, showing Transverse Arched Flooring.

The method of erection also, as regards the ironwork structure, presents a number of interesting features that will doubtless provoke admiration in the mechanical engineer who follows it carefully: it may be said with truth that the ingenuity shown throughout the building of this line along a crowded route without any interruption of business or traffic, is praiseworthy to a degree. For the purposes of these pages, however, it is more important to confine the remainder of this description of the line to its essentials as a railway operated by means of electricity; and to that end some particulars will next be given of the rolling-stock employed.

(*To be continued.*)

NOTES ON CENTRAL STATION WORKING.*

BY W. BREW AND P. G. LEDGER.

INTRODUCTORY.

In bringing the following few notes before you our object has been to avoid as far as possible a mere record of tests and figures, and to select out a few salient points for discussion from the central station routine which have appeared to us of importance, or from which at any rate we ourselves have experienced trouble. with the hope of obtaining the benefit of the experience of some of you under similar or parallel circumstances. The amount of subject-matter at hand and ready for investigation in the case of the central-station engineer is no doubt great, but there are, unfortunately, difficulties of many sorts to be overcome in making accurate experiments and the "working in" of reliable tests into the daily routine, which, of course, as a rule, cannot be interfered with, is not always an easy matter.

We propose to treat the subject-matter in four sections, and in the following order: 1. Boilers. 2. Engines. 3. Dynamos. 4. Switchboards, instruments, etc.

BOILERS.

One comes across abundance of figures relating to the testing of very efficient boilers in the technical journals, and nearly every engine-maker will be able to show you some test figures of an efficient performance of the engines and boilers he turns out, but when you come to examine a central-station coal bill and work out your coal consumption per horse-power hour, things always do not look so happy; we do not mean to say that the stock figures put forward by the engine-makers are incorrect, but merely wish to lay stress upon the difference between coal and water consumption during an engine test superintended by a professor of engineering, for instance (who watches the placing of each shovelful of coal and is constantly rendering admonitions), and the ordinary everyday coal and water consumption of the same engine when at work in a central station, and probably under very different conditions. The figures obtained by an expert's test as showing what can be done by care and attention, are no doubt very valuable, and especially so to the man who wants to sell the engines, but the figures which interest chiefly the shareholders and managers of electric lighting stations are those giving the ordinary everyday coal and water consumption and load efficiency under the working conditions of the central station. Bearing these facts in mind, we propose to avoid recording in this paper any tests during which more than the normal amount of care and attention was paid to details, and to give you the results of a few experiments made by us with plant in various places working under its normal conditions. The following experiment, made upon two Lancashire boilers, length 24ft., diameter 6ft. 6in., flues 2ft. 6in., as regards their coal consumption per pound of water evaporated, starting with cold feed-water and gradually raising its temperature by means of the exhaust steam from the engines supplied, may perhaps be of interest.

The curve, Fig. 1, give the results of an eight-hour test, the difference in the inclination of the curves representing consumption of coal and water respectively indicates, of course, that the evaporation of the boilers is increasing as the temperature of the feed-water is raised. A few practical points in the working of boilers from which we have experienced trouble at times may, perhaps, be worthy of note. When the exhaust steam from the engines is condensed, it is very necessary that special precautions be taken to exclude grease and oil before using the water again for feeding purposes, and more care seems to be necessary in the case of high-speed engines; a boiler once having got grease into it, may cause considerable trouble from leakage at tubes and riveted joints, defying all caulking, etc. Another point to be considered where heated feed-water is used is the position of the feed-pumps, for if the height from the pump to the surface of the water exceed a few feet, and the water is anywhere near the boiling point, the pump will often refuse to work, being unable to lift the water as the diminished pressure on its surface in the suction-pipe causes steam to be given off readily, and effectually prevents the rising of the hot water in the suction-pipes. If the type of water-heater used will stand the pressure, probably the best place for the pump is between the cold water supply and the heater, so that the cold water is forced through the heater into the boiler. This section of the subject was concluded by the authors calling attention to a few of the specimens of boiler-tube and shell, etc. (some of them from actual breakdowns), which they had brought for inspection.

ENGINES.

Where so much depends upon the continuous and steady running of the engines it is imperative that great care and attention should be paid to every detail, the indicator should be used frequently and judiciously, and every engine after being touched by a fitter should be regarded with suspicion until it has been thoroughly tried with full load; in fact, the central-station engineer should be always measuring and testing, and every piece of plant in the station should be used and tried periodically. Too much importance cannot be placed upon such details as these, and a stand-by which is never used as often as not proves quite useless in an emergency, with a result sad to contemplate. With regard to the efficiency of high-speed engines, or of combined engine and dynamo, the usual figures will be so well known to you; in fact, they differ so little with the machinery of any good maker that we will not weary you by recording any lengthy tests, but propose to pass on to the question of governing, and to give you our experience of a few new types of governor. We might mention, however, in passing, that the figures we have usually obtained with the types of high-speed direct-coupled engines and dynamos we have tested lie between 70 per cent. and 78 per cent. commercial efficiency, meaning a loss of about 5 per cent. to 10 per cent. in the dynamo, and from 10 per cent. to 18 per cent. in the engine. The efficient working of the governor is a very necessary and important feature about engines for electric lighting purposes, and in the early days of electric lighting it was not an uncommon thing for the governor to stick or its belt to come off, causing the engine to race away and smash all the lamps on the installation. We may perhaps broadly classify the governors at present in use on electric lighting engines under two heads:

First, as the ordinary type, in which a piston or equilibrium valve, actuated by a rod passing through a stuffing-box, is used to throttle the live steam, such as in the Willans, Marshall, Belliss, and numerous other types of high-speed engine.

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* Paper read before the Old Students' Association.

Secondly, as the extraordinary type, under which heading would be classed such types as the Corliss, Proell, Robey, Hartnell, etc., acting on the "cut-off." Now it will be obvious that, however perfect our governor may be, unless we have also a suitably-designed flywheel, we may experience considerable variations in speed when our wheel does not possess a sufficient store of energy to carry us comfortably over the dead points which react upon the governor and increases the evil.

A point to be borne in mind, and especially applicable to single-cylinder slow-speed engines, is that, supposing our governor to be perfect or to act instantaneously upon any increment in speed, it will be obvious that at the time of "cutting off" or "throttling," as the case may be, we have a certain state of energy in the steam already admitted to the cylinder and about to expand, to which, in the case of condensing engines, we must add the effect of the condenser, and therefore after the "cut off" has taken place, we see that the ultimate variation in speed is a question of weight of flywheel, position of crank, etc., which cannot be influenced by the governor until the back stroke. This is proved by the increased steadiness we get when two such engines are coupled together. We have then the advantage of adjustment by the governors four times in one revolution of the crankshaft. The following experiment may be of interest as illustrating a few points with regard to the acting of what we have called an ordinary type of governor. The experiment was made by one of us upon a small vertical engine of about 8 h.p. nominal, of which the following are the chief constructive data:

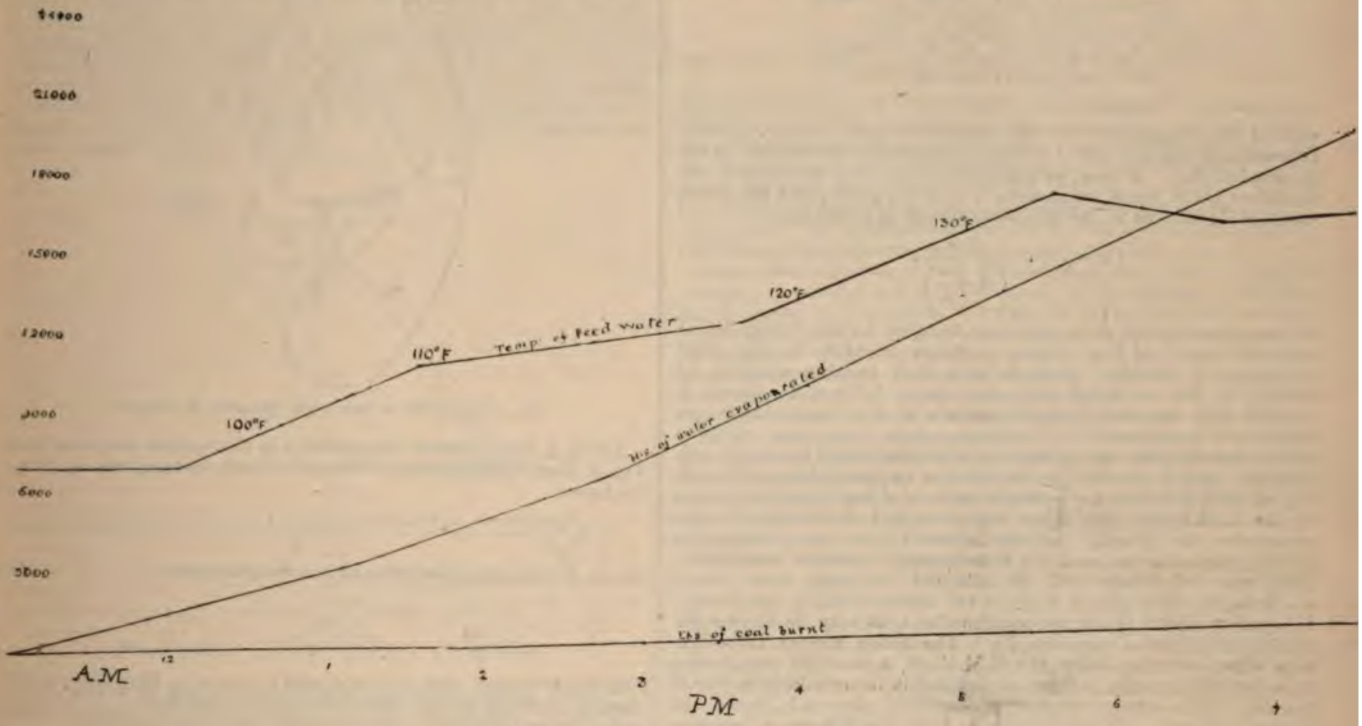


FIG. 1.—Curves of Consumption of Coal and Water.

Diameter of cylinder = 12in.
,, piston-rod = 2in.
Length of stroke = 16in.
Normal speed of crankshaft, 115 revolutions per minute.
Diameter (outside) of flywheel = 5ft.
Section of rim of flywheel = 9½in. breadth by 2in. deep.

The experiment consisted in gradually increasing the load on the engine by means of a Prony brake, and taking careful observation of the indicated horse-power and the variation in the speed of the engine. The following table gives a few of the results obtained:

TABLE II.

Steam pressure. Boiler.	Speed of engine.		Horse power indicated.	Remarks.
	Average	Per cent. variation.		
lbs. per square inch				
79	123	0·6	4·70	Engines running light
,,	115	1·5	11·59	
,,	114	3·5	20·5	
,,	115	2·2	25·37	Governor hunting occasionally.
,,	114	33·3	32·12	Governor hunting badly.
,,	113	50·0	45·47	Engine labouring heavily.

Towards the end of the above experiment, the engine appeared to be so badly strained that it was considered advisable to push the test no further. The table shows us, besides other things, that we may overload such an engine up to a certain point with a comparatively small increase of unsteadiness, but that after this point has been reached the unsteadiness increases so rapidly as to render the engine practically useless. By throwing the governor out of gear, the unsteadiness was confined almost altogether to a beat at the dead points, and was much diminished, so that a greater amount of work could be obtained from it.

The following is a governor test, also made with an ordinary type of governor, but fixed to a special form of compound high-speed engine made by Messrs. Belliss and Co. The engine was coupled direct to a Siemens dynamo, with an output of 450 amperes at 130 volts terminal potential difference. The chief dimensions of the engine were as follows:

Diameter of high-pressure cylinder ...... = 11·5in.
Diameter of low-pressure cylinder .... = 18·0in.
Diameter of piston-rods .... = 2·5in.
Length of stroke............................ = 11·0in.

The test consisted in breaking the dynamo circuit at various loads, and noting the temporary and permanent variation in the speed of the engine as given by the tachometer. The results obtained are given in the following table:

Dynamo circuit made.				Dynamo circuit broken.			
Steam press.	Current in amps.	P. D. at terminals.	Steady tachometer reading.	Tachometer readings.			Permanent % increase.
				Max.	Permanent.	Max. % increase.	
84	120	130	357	390	368	9·24	3·08
84	125	,,	366	394	366	8·32	0
81	200	,,	351	405	557	15·38	1·71
76	240	,,	354	420	360	18·64	1·69
83	350	,,	357	420	366	17·64	2·52
82	350	,,	357	423	369	18·48	3·36
80	450	,,	360	426	373	18·33	3·61
82	450	,,	360	426	369	18·33	2·50

With regard to the efficiency of this engine and dynamo, we might mention that we found the commercial efficiency at the end of an eight hours' run to come out at slightly over 73 per cent. We will now pass on to consider a few of what we have called the extraordinary type of governor. One of these, which is no doubt well known to most of you, is that of Hartnell. This governor, which controls the cut off by means of an expansion-valve of variable travel, riding on the top of the ordinary D-valve. [Diagrams were shown.] We should like to dwell much longer upon this all-important question of governing, but we fear the limits of the present few notes will not permit of it, and we must therefore conclude this section with a description of the Proell expansive gear, invented by Dr. Proell, and introduced into this country by Messrs. Marshall, Sons, and Co., of Gainsborough. This gear, belonging to a class known as trip gears, is now well known. The live steam is brought to a steam-chest on the top of the cylinder, to which it is admitted by means of an equilibrium valve at each end. The exhaust is similarly accomplished by a Corliss valve at each of the bottom ends of the cylinder, the facilitating the exit of water. The admission valves are actuated by means of a rocking-frame carrying two bell-crank levers, one end of which engages with and depresses the valve-openers until tripped by the part whose position is determined by the governor It will be seen that by this arrangement practically all the work of opening the valves is done by the rocking-frame, and not by the governor, which, of course, means a great increase in sensibility. [Indicator diagrams taken from a 200-h.p. Proell engine were shown.]

DYNAMOS.

If n machines of resistance $r_1, r_2, r_3 \ldots r_n$, and E.M.F. $e_1, e_2, e_3 \ldots e_n$ respectively be joined up in parallel to an external circuit of resistance, R, it is easy to show that the current in this external circuit will be:

$$\mathrm{C_R} = \frac{e_1}{r_1 + \mathrm{R}\left(\frac{r_1}{r_1}+\frac{r_1}{r_2}+\frac{r_1}{r_3}+\frac{r_1}{r_4} \ldots \frac{r_1}{r_n}\right)};$$

$$+ \frac{e_2}{r_2 + \mathrm{R}\left(1+\frac{r_2}{r_1}+\frac{r_2}{r_3}+\frac{r_2}{r_4} \ldots \frac{r_2}{r_n}\right)};$$

$$+ \frac{e_3}{r_3 + \mathrm{R}\left(1+\frac{r_3}{r_1}+\frac{r_3}{r_2}+\frac{r_3}{r_4} \ldots \frac{r_3}{r_n}\right)};$$

$$+ \text{etc.},$$

each of the expressions on the right-hand side of the equation representing the amount of current one machine contributes to the external circuit. If now, as is generally the case in practice, the machines are of equal resistance, $r_1 = r_2 = r_3$, etc., and the above value of $\mathrm{C_R}$ reduces to the following simple expression:

$$\mathrm{C_R} = \frac{1}{n} \cdot \frac{\Sigma e}{\left(\mathrm{R}+\frac{r}{n}\right)},$$

or the current in the external circuit is equal to the arithmetical mean of the E.M.F.'s of the machines divided by the total resistance in circuit. Suppose now that another machine of E.M.F. e', but of equal resistance to its fellows, is placed in parallel with the rest, from the nature of the numerator we see that it will be increased if e' is greater than the average and *vice versâ*; also that the denominator will be diminished by every such addition, and if we consider the effect of various values of e' upon $\mathrm{C_R}$, we shall find that for a certain value of e' less than the average of the E.M.F.'s of the other machines, the diminution in the numerator is exactly counterbalanced by the diminution in the denominator, and $\mathrm{C_R}$ consequently remains unaffected. This state of things will be attained in every case where $e' = \mathrm{R\,C_R}$, or when the E.M.F. of the machine being introduced is equal to the P.D. at the omnibus bars, as may be shown by substitution in the value for $\mathrm{C_R}$. The above simple investigation shows us what value the E.M.F. of a machine must have in order that, at the instant of putting it in or taking it out of parallel with others, no flicker may be observed upon the lamps in circuit. It also shows us that the difference between the value $\frac{1}{n}\,\Sigma e$ and $\mathrm{R\,C_R}$ is due to the loss of volts in the armatures—*i e.*, $\mathrm{C_R} \times \frac{r}{n}$—and that for a given load or value of $\mathrm{C_R}$ the greater the number of machines in parallel, the less this difference becomes; the practical bearing of this is that it is unwise to run more machines than necessary upon a given load, as there is more danger of reversals from slight variations in speed.

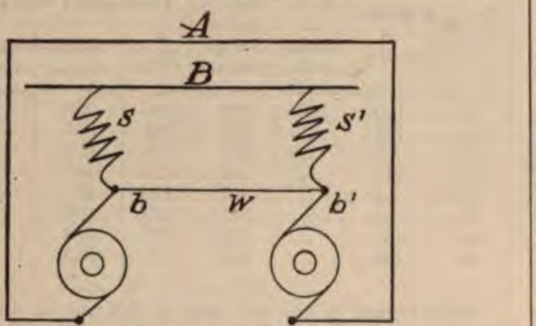


FIG. 2.—Diagram of Compound Dynamos in Parallel.

A point about which few, if any, of the text-books give us any information, beyond a description of the connections, is the running of compound dynamos in parallel. Perhaps this is due to the fact that, from the point of view of a theoretically perfect compound dynamo, no difficulty should be encountered; but in practice we think we may fairly say that the operation is sometimes a little "tricky," and some of the difficulties only become of importance with machines of fair size and under the conditions of a fair output. It is a well-known fact that an overcompounded dynamo will not run satisfactorily as a generator supplying a shunt motor if motor and generator be nearly the same size. A practical case of this has been described by Mr. Kapp. Other facts equally certain, but perhaps not so well recognised, are: That two overcompounded machines will not run satisfactorily in parallel; neither will two so-called compound dynamos whose characteristic (of terminal P.D. and current) deviates much from a straight line. In considering the causes of these phenomena, we think we shall be able to classify them under two main heads—(1) those due to the form of the characteristic of the machines concerned; (2) those due to the effect of considerable self-induction coming into play with a rapid variation of the load on one or more of the machines, and a consequent lag of P.D. at its terminals. But before doing so, let us remind you of some of the points in which compound machines as connected for running in parallel, chiefly differ from shunt dynamos. Fig. 2 represents diagrammatically the superstructure, where $s\,s'$ are the additional series-turns, w a wire or bar joining the inside brushes, $b\,b'$, and A and B represent the omnibus bars. If we suppose the bars, A B, to have little or no resistance, or better, suppose the external circuit connected midway between the two machines, and add the resistance of one bar to each of the series-turns of the dynamos, we find that the above connections reduce themselves to the well-known lozenge-shaped diagram of the Wheatstone bridge, the balancing wire taking the place of the galvanometer, as in the next figure.

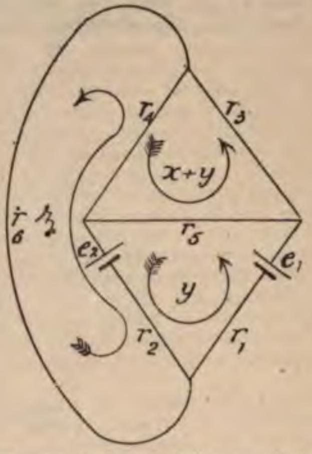


FIG. 3.—Diagram of Compound Dynamos in Parallel.

Let x, y, and z denote the currents in the various sections, as in Fig. 3, then writing out the value of x from determinant analysis, we have:

$$x = \frac{e_2\,(r_3\,r_4 + r_3\,r_6 + r_4\,r_6 + r_4\,r_1) - e_1\,(r_3\,r_2 + r_3\,r_4 + r_3\,r_6 + r_4\,r_6)}{\Delta}$$

where Δ represents the value of the determinant;

$$\left|\begin{array}{ccc} r_3+r_4+r_5 & r_3+r_4 & -r_4 \\ -r_5 & \underline{r_1+r_2} & -r_2 \\ -r^4 & -r_2+r_4 & r_2+r_4+r_6 \end{array}\right|$$

We see, therefore, that if $e_1 = e_2$ and $r_4\,r_1 = r_3\,r_2$, then the current flowing in the balancing wire will be zero, but that if $r_4\,r_1 = r_3\,r_2$, and e_1 be not equal to e_2, then we have for our value of x—

$$x = \frac{e_2 - e_1\,[r_4\,(r_3 + r_6) + r_3\,(r_2 + r_6)]}{\Delta},$$

or the current through the balancing wire will be proportional to the difference in the E.M.F. of the machines.

Consider now the currents $x + y$ and $x + y - z$ in the branches r_3 and r_4, or the currents flowing through the series-turns of the machines, denoting these by A and B respectively, and in their expressions putting $r_5 = 0$, we have

$$\mathrm{A} = \frac{e_2\,(r_4\,r_1) + e_1\,(r_4\,r_2)}{\Delta}$$

$$\mathrm{B} = \frac{e_2\,(r_3\,r_1) + e_1\,(r_2\,r_3)}{\Delta}$$

from which we see that if $r_3 = r_4$, in addition to r_5 being $= 0$, then the currents through the series-turns will be equal: that is to say, if the two machines running in parallel have equal resistance in their series-turns, and the resistance of the balancing wire is small, whatever the difference between e_1 and e_2 may be, the currents in the series turns of the machines will be approximately equal, and independent also of the armature resistances. The above simple investigation therefore shows us two things: firstly, that in order to run two compound machines in parallel efficiently, they should be of the same size, or, at any rate, have equal resistance in their series-turns; secondly, the balancing wire connecting the two machines should be of low resistance, and not a fine wire, as is sometimes stated in the text-books.

Having now refreshed our memory with the conditions under which the compound machine works, let us now consider some of the phenomena mentioned above. Fig. 4, which we think will explain itself, represents the characteristics of two compound dynamos which could not be got to run in parallel until the compounding had been altered; the fact of the matter was that the speed of the machine had been altered to accommodate a greater drop of potential difference along the mains than was at first estimated for. A glance at the upper part of the curves will show that the machines were overcompounded at this speed, and it will be evident that two such dynamos working in parallel will be in a state of unstable equilibrium, for assuming the machines to have a load equally divided between them at the start and anything to occur to alter this condition, such as the joint of a belt running over a pulley, or a slight variation in the speed of the engine if the machines are direct driven, then that dynamo which has come off best with regard to the load has the P.D. at its terminals increased, while the reverse is the case with its neighbour, which rapidly relinquishes the remainder of its load to its stronger brother and is promptly reversed—a proceeding generally accompanied by a fair pyrotechnic display at the commutators of both machines. Again, take the case of a somewhat common characteristic of a large machine, in which the terminal P.D. rises until half the load is on, then gradually falls until at full load it has the same terminal P.D. as on open circuit, it will be obvious that two such machines running in parallel will also be in a state of unstable equilibrium for certain light loads. We see, therefore, that the possibility of running compound machines satisfactorily in parallel depends to a considerable extent on the form of their characteristics.

We now come to consider the second class of effects—*i.e.*, those due to self and mutual induction in the machine itself. In December, 1890, in a letter one of the present authors gave some curves illustrating the lag of induction through the armature of a large dynamo behind the magnetising current producing it, and it will be obvious that although the self-induction of the series-turns may not be so great as that of the shunt winding, still an effect of this nature will be of considerable importance in switching large compound machines rapidly into parallel. Suppose, for example, we have two machines, A and B, and we require to put A in parallel with B which is loaded, and suppose we note the P.D. at the terminals of B, and make the E.M.F. of A slightly greater (by altering the speed of the engine or otherwise) so that A will take up some of B's load as soon as we close the switch, we see then that B will behave as an overcompounded machine and A the reverse for a short interval.

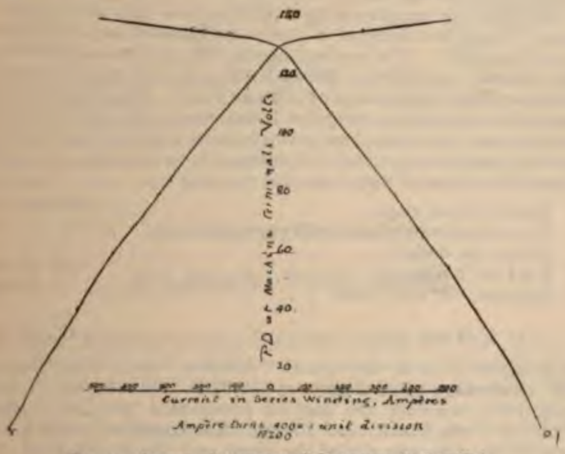


FIG. 4.—Curves of Compound Dynamos in Parallel.

We have seen that we may express the final steady value of a current which will flow through a machine (when put in parallel, and shortly after the switch is closed) in terms of its E.M.F. and an effective resistance, involving the resistances of the other machines already in parallel between the omnibus bars and the resistance of the external circuit.

Let I = the final steady current through the armature and series winding of the machine ;
,, E = the E.M.F. of the machine ;
,, R = the effective resistance, the relation $I = \frac{E}{R}$ being supposed to hold as usual.

In the ordinary state of affairs, the shunt circuit will be closed, of course, and a steady current will be flowing through it from the omnibus bars, and the only effect of importance upon this steady current, when the main switch is closed, will be that due to mutual induction between the shunt and the main circuit through the armature and series-turns.

Let M = the mutual induction between the two circuits, and denote by y the instantaneous value of any increment to the steady shunt current (due to this mutual induction) at any time t, similarly denote by x the instantaneous value of the main current at any time, t, before it reaches its practically steady value, I.

Let L = the self-induction of the main circuit, whose resistance we have denoted by R ;
,, S = the resistance of the shunt winding ;
,, N = the self-induction of the shunt winding.

Now it is well known that for circuits containing iron, the quantities L, N, and M are variables depending upon the induction, B, but if we consider that in the case before us our magnet is already highly magnetised, we think you will agree that the amount by which $\frac{\delta B}{\delta x}$ varies throughout the range we are considering, will be practically negligible, and this being the case, we may employ the usual method of solution for two mutually inductive circuits of constant inductance. We have then for our fundamental equations:

$$L\frac{\delta x}{\delta t} + M\frac{\delta y}{\delta t} + Rx = E \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$N\frac{\delta y}{\delta t} + M\frac{\delta x}{\delta t} + Sy = 0 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Differentiating and separating the differentials in x and y, we get :

$$\frac{\delta^2 x}{\delta t^2} + \frac{SL + NR}{(NL - M^2)}\frac{\delta x}{\delta t} + \frac{RS}{(NL - M^2)}x = \frac{SE}{(NL - M^2)} \quad . \quad (3)$$

$$\frac{\delta^2 y}{\delta t^2} + \frac{SL + NR}{(NL - M^2)}\frac{\delta y}{\delta t} + \frac{RS}{(NL - M^2)}y = 0 \quad . \quad . \quad . \quad . \quad (4)$$

the general solutions of which are:

$$x = Ae^{m_1 t} + Be^{m_2 t} + \frac{E}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$y = A'e^{m_1 t} + B'e^{m_2 t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and upon investigation we find the following values for the constants :

$$m_1 = -\frac{(SL+NR) + \sqrt{(SL+NR)^2 - 4RS(NL-M^2)}}{2(NL-M^2)}$$

$$m_2 = -\frac{(SL+NR) - \sqrt{(SL+NR)^2 - 4RS(NL-M^2)}}{2(NL-M^2)}$$

$$B' = -A'$$

$$B = -(I+A)$$

$$A' = \frac{IMS}{\sqrt{(SL+NR)^2 - 4RS(NL-M^2)}},$$

and $$A = \frac{e^{m_2 t}(m_2 A'M + m_2 IL + IR) - m_1 e^{m_1 t} A'M}{e^{m_1 t}(m_1 L + R) - e^{m_2 t}(m_2 L + R)}.$$

Upon substituting the numerical values of these expressions in (5) and (6), we can calculate the value of x and y. At any time, t, after the closing of the main switch. Curves plotted from the above equations, however, do not agree very well with experiment, for we have a distortion of the field as the current rises in the armature, and also a lag of induction ; we will therefore show you some of the experimental results we have obtained with our photo-recording ammeter and voltmeter now before you.

Regulation.—The usual way of regulating large shunt machines working in parallel and coupled direct to the engine, is by varying the speed of the engine by means of an adjustable governor, increasing or diminishing the tension of its spring according to the potential difference required at the machine terminals. An adjustable resistance in the shunt of the machine is sometimes used, but with a fair-sized dynamo this system of regulation is quite inadequate to cope with rapid variations in the load.

In the case of a sudden load being thrown upon a machine direct driven, the speed of the engine may be raised quickly, and then lowered a little as the current rises in the shunt. In most cases, however, the loads thrown suddenly on the machine are not sufficient to cause any serious fall of potential difference, and the regulation may therefore be effected gradually.

What occurs in an ordinary central station when a sudden fog comes on, is probably well known to most of you ; for instance, there is a certain amount of swearing among the stokers when extra steam is required, a good deal more than the average amount of coal is burnt in the time, and a higher rate of activity generally is required of the staff. But beyond these circumstances there are perhaps a few details in the routine which deserve attention, such as the effect of sudden and considerable increments to the load, and the working efficiency of the plant under these rapidly varying conditions. First, let us consider the way in which some customers switch on and off their light. In the case of most large business houses coupled to a direct-current supply system, there is a main switch usually placed in a cellar or other room where the company's mains terminate and the customer's house-wiring begins, and it is remarkable in what short space of time, after the installation of electric light upon the premises, the average draper's assistant's thirst after scientific knowledge will teach him that it is not necessary for him to run through all the departments after closing hours to switch off the light, but that he can accomplish this, and with much less trouble to himself, by retiring to the cellar and opening the main switch, at the same time, perhaps, closing and opening it a few times to get the impressive effect of the spark. It will be obvious that a few such business houses, taking from 100 to 200 amperes, and behaving in this manner, will become a nuisance to the central-station engineer, and especially so if, as often happens, two or more houses switch on or off at practically the same time. Now take the case of a station running with shunt machines direct coupled to their engines, the number of dynamos connected to the omnibus bars depending, as usual, upon the demand of the customers at any time. In most stations of this type each dynamo is provided with an automatic cut-out placed between one or both of the machine terminals and the omnibus bars, whose duty it is to cut off automatically the machine in the event of a reduction in its E.M.F. due to a hot bearing or other cause, thus saving the armature, whose E.M.F. has been reduced from destruction by the other machines coupled in parallel with it. Now, although an automatic "cut-out" may work with theoretical preciseness with an ordinary varying current, it is rash to rely upon it under the conditions of a sudden increment or decrement in the current passing through it, for, owing to the inertia of the moving parts (which must be made somewhat large to carry the current), many of those at present in the market will vary considerably in their point of "cut off." Thus it happens that upon visiting some central stations, and examining closely some elaborate piece of mechanism of this nature, we discover a substantial wooden wedge or piece of stout whipcord to be necessary to the satisfaction of the engineer in charge, rendering the ingenious and admired apparatus quite passive as regards either service or mischief. When fair-sized motors are coupled to the mains, they do not tend to improve the steadiness of the light, for their load is constantly varying with uncertainty; and although a blessing in helping to keep up the all-day efficiency of the plant, we think matters would be improved if they could be run off mains distinct from the lighting-mains (that is, unless the present demand increases, and becomes so general as to keep a fair amount of plant constantly employed), for it is during the day when the lighting load and plant occupied is least that their effect becomes most noticeable. And then, again, supposing this demand to have increased, central stations would be overloaded on a foggy day, unless they possessed more than the usual amount of reserve plant. Some kinds of electric lighting also, such as that of theatres, often require for stage effects, etc., rapid and considerable variations of current, as will be seen on reference to the curves, Figs. 5 and 6, which represent the variations of current leaving the engine-room during the operas of "Ivanhoe" and The "Basoche" at the late Royal English Opera House. But the redeeming feature of theatre-lighting from a supply station is that the station people know within a minute or two when the load will vary, and the amount of its variation, and are therefore on the look-out for it. The question arises, How shall we regulate matters in the engine-room to avoid undue flickering in those lamps which form the steady part of the load? There are several recognised methods by which approximate steadiness may be attained; that method which is best depending in any particular case very much upon the nature of the load, the plant available, and last, but not least, the skill and judgment of the engineer in charge. Some people think when they enter a central station that the whole day's work may be summed up into the watching of a voltmeter or a steam or water gauge, but, granted that these are important duties, they are still somewhat wide of the mark, and under the conditions of hot bearings, obstinate feed-pumps, blowing joints, and other kindred evils with which the engineer has to contend, his skill is sometimes taxed to bring matters to a successful issue.

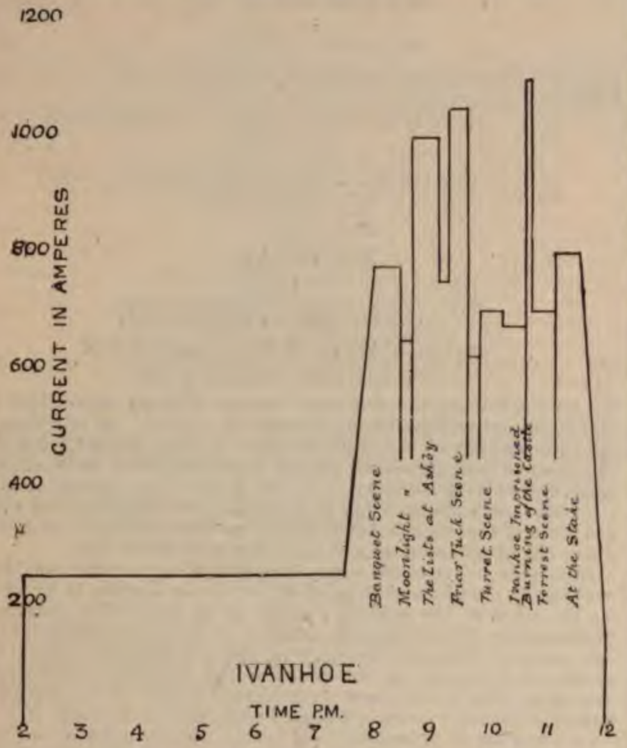


FIG. 5.—Load-Curve during "Ivanhoe."

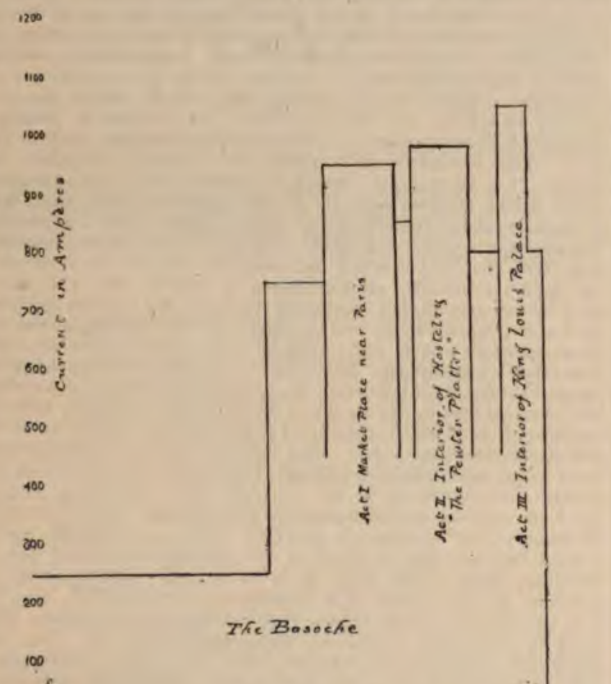


FIG. 6—Load-Curve during Performance of "La Basoche."

The late Royal English Opera House, although coupled to the mains of the Metropolitan Electric Supply, was ordinarily worked from its own installation, which we think may be taken as quite a model of its type, and propose to give you a few particulars of its working in the event of some of you being interested in theatre lighting.

The lighting arrangements, under the management of Mr. J. Peschek, were carried out with no small amount of skill and economy, when we consider the somewhat trying conditions of the working. For instance, the great necessity of crispness in response to signals, and the manipulation of large and varying loads thrown suddenly upon and again taken as rapidly off the engines, of keeping boilers under steam for several hours for the special requirements of perhaps an hour or so, etc., and many other items.

The installation comprises three locomotive boilers (by Marshalls), supplying with steam three Willans compound engines coupled direct to Siemens shunt dynamos, having an output of 650 amperes each at 100 volts. A set of 108 E.P.S. 31L accumulators are also used for supplying light during the day throughout the house. These are charged in three sets parallel and discharged in two sets parallel. The current leaving the engine-room during an opera usually varied from 600 to 1,200 amperes, and the total consumption from 300 to 550 B.T.U. per diem. The following items compose the cost of running the installation per diem with seven performances per week, two performances usually being given on Saturday, and about three full rehearsals in a month, the results being the average of some months' running:

Engine-room wages ..	£1	19	0
Depreciation of plant at 10 per cent.	3	0	0
Water for boilers	0	2	0
Fuel for boilers	2	2	0
Repairs, oil, and waste	0	11	0
Total	£7	14	0

Taking the case of the operas "Ivanhoe" and "The Basoche," with an average consumption of 459·37 B.T.U. and 524·25 B.T.U. respectively, we find the cost of production per B.T.U. during "Ivanhoe" was 4·02d., and during "The Basoche" 3·52d., which, when we consider the size of the plant and the trying load curve, is not, we think, at all bad.

STANDARD INSTRUMENTS.

We will bring our notes to a conclusion by a few brief remarks on standard instruments. In order to obtain anything like efficient working of a central station, it is, of course, necessary to be able to check at frequent intervals the accuracy of the various ammeters and voltmeters in the place, and the arrangement which we will now discuss is, we venture to think, as simple and reliable as any for ordinary purposes. There is nothing at all original about it, it being essentially the same as has been in use at the Central Institution for some years past, also by Messrs. Willans and Robinson at Thames Ditton (as described in a paper before the Institution of Electrical Engineers, November 12, 1891), and many others (*vide Electrical Engineer*, November 13 and 20, 1891). A D'Arsonval galvanometer (with a magnetic shunt), D'A, is in series with a resistance-box ranging up to 10,000 ohms, R, and across the latter is connected a standard cell, C, a fairly sensitive galvanometer, G, and any unknown but high resistance, R_1. Suppose the standard cell to give, say, 1·435 volts at a certain temperature, and let R be adjusted to 143·5 ohms, and an adjustable source of P.D. be connected to A and C, it is evident that when on pressing the key, K_1 there is no deflection on G, the current in R, and, therefore, in D'A, is one milliampere, and by adjusting the magnetic-shunt, this current may be made to produce a deflection on D'A of, say, 100 divisions. This experiment can be tried at any time, and should the deflection be found to have altered it can be re-obtained by adjusting the magnetic shunt.

Now to use the instrument as a standard voltmeter. Suppose its resistance is 10 ohms, then if R be adjusted to 990 ohms, the total resistance in the circuit will be 1,000 ohms, and, therefore, one volt gives 100 division deflections. Suppose the scale to range from 0 to 500 divisions, we thus have an accurate range of measurement up to five volts. Now increase R + G to 10,000 ohms, we thus get a range to 50 volts; again R + G = 10,000 ohms and $\frac{1}{10}$th shunt in G, we have a range to 500 volts as per table. We have here assumed that the D'Arsonval galvanometer gives deflections throughout its range which are proportional to the currents passing—*i.e.*, 500 divisions is caused, for instance, by a current five times as strong as that giving 100 divisions.

This we believe always can be relied upon if the instrument is carefully made and the coil suspended so as to hang from its point of support—viz., with its centre of gravity vertically beneath the point of support—which is effected by causing the lower connection of the swinging coil to be made of a thin spiral of wire offering no torsional rigidity as explained by Prof. Ayrton in his remarks on Captain Sankey's paper mentioned above. Having thus obtained an extremely accurate voltmeter, it now remains to be seen how the arrangement can be made to act as an ammeter. A choice of two methods is open to us. One method is to put a silver or copper voltameter in series with the strip, and adjust it so that a certain steady deflection is produced on D'A (which is shunted to the strip) and afterwards determined from the increase of weight of the voltameter plate what current has been passing. This, though an extremely accurate method, takes time, and is not very easy of application. In the other method, the known resistance, K (which must be capable of carrying one ampere without appreciable temperature) is inserted in place of the voltameter, and the standard cell placed across its terminals as shown. For the sake of convenience, suppose K = 1·435 ohms and S = ·01 ohm ; then if the main current be adjusted until on pressing the key, K, no deflection is shown on G, then we know that one ampere is passing, and therefore ·01 volt is the P.D. at terminals of S. Suppose D'A to have 10 ohms resistance, and all R is to be short-circuited, then the current in D'A will be ·001 ampere, which, as we have before seen, gives a deflection of 100 scale divisions. This is an extremely simple test, which can be applied in a minute or two, and shows exactly if the resistance, S, has altered in value. Supposing, however, it has the value mentioned—namely, ·01 ohm—then we have, as table below shows :

Resistance in D'A circuit.	Value of 100 scale divisions.	Maximum range 500 divisions.
10	1 ampere	5 amperes.
100	10 ,,	50 ,,
1,000	100 ,,	500 ,,

We believe that the method described will give very nearly, if not quite, the accuracy of a Thomson balance and delicate standard voltmeter at a very much lower cost. In conclusion, we desire to express our thanks to Mr. F. W. Goddard, who has practically taken upon himself the illustration of the paper, also to Messrs. Marshall, Sons, and Co., of Gainsborough, and others for their kind assistance.

STANDARD FUSE WIRES.

Messrs. Shippey Bros., Limited, notify us that they have been appointed sole European agents for the sale of the Sperry tested fuse wire, as manufactured by the Sperry Electric Mining Machine Company. of America, and as such agents Messrs. Shippey Bros. will hold stock of over 30 sizes, with capacity from ¼ ampere to 500 amperes. These wires are made from a special alloy, and are got up in lengths of 100ft. for the small sizes, 50ft. for medium sizes, and 25ft. for the largest sizes, which are packed in a very convenient form on metal reels. It may be noted that the Sperry tested fuse wire has been selected for the entire work at the World's Fair, Chicago.

THE SPERRY ELECTRIC MINING MACHINE CO.
10 AMP.
FUSE WIRE
WARRANTED
CHICAGO

CROYDON.

MR. PREECE'S REPORT

At the meeting of the Croydon Town Council last week, the General Purposes Committee reported as follows :

The committee considered a report from Mr. Preece as to what additional expense would be involved by the installation and plant for lighting the new Town Hall and library, being of sufficient capacity also to supply consumers within the compulsory area, and being designed with a view to future extension. Copies of Mr. Preece's report have been circulated among the members of the Council.

The committee recommend that the Council carry out the lighting of the compulsory area, as recommended by Mr. Preece, at the estimated cost, but raising £5,000 instead of £2,500 for buildings, making a total of £22,500, subject to the sanction of the Local Government Board being obtained to a loan for the latter amount, and they recommend application being made to the Local Government Board for sanction accordingly. The committee requested the sub-committee, as soon as sanction is granted, to take the advice of Mr. Preece as to inviting tenders for the necessary work. Copies of the plan referred to in Mr. Preece's report may be seen at the Town Hall.

The committee further recommend that the sub-committee be authorised, if they deem it necessary, to apply for an extension of time within which to exercise the powers granted by the Corporation's provisional order.

REPORT.

The following is Mr. W. H. Preece's report :

The Town Clerk, Town Hall, Croydon.

SIR,—In accordance with instructions contained in your letter of September 28, I beg to say that I have very carefully gone into the questions referred to me—viz. (*a*) The cost of an installation for the supply of electricity to the new Town Hall and free library, and (*b*) of an installation of sufficient capacity not only to light the new Town Hall and library, but to supply consumers within the compulsory area, and designed with a view to future extensions.

I should like to say at the outset that I am glad to see that there is a chance of your Corporation undertaking its responsibilities in this matter of electric lighting. You say your Town Council have advertised for offers to take over the powers conferred upon them by their provisional order, but that no offer has been received sufficiently tempting to be acceptable. I conclude that your Council are fully alive to the fact that in their provisional order they possess a very valuable property, which they will not determine hastily to dispose of.

When I last reported to you on this question, in September, 1890, I urged upon your Corporation the desirability of commencing a comprehensive scheme of electric lighting, embracing the whole of the borough area, but which should be commenced on a small scale, and extended as opportunity offered and as necessity arose. At that time municipal bodies had done but little practical work as undertakers for the supply of electrical energy. Their action had been restricted practically to securing provisional orders, as your Corporation has done. Now, however, the position is quite different. The supply system of the Bradford Corporation has been in operation just over three years, and it has already become a paying concern, standing fairly on its own bottom, independent of the rates, and without doubt destined to become a certain source of municipal income, to be applied to the relief of the rates.

The New Town Hall.—By favour of Mr. Henman, I have had the plans of the new Town Hall carefully examined, and the building itself inspected, and I estimate that for the efficient lighting of the whole of the premises, the equivalent of 650 lamps of 16 c.p. will be required.

Practically the whole of the lamps on the upper floors should be 16-c.p. lamps, but in the basement it may be possible in some instances to use 8-c.p. lamps. Thus 100 of 16 c.p. and 60 of 8 c.p., or a total of 160 lamps would be equivalent as far as consumption of energy is concerned, to the 130-c.p. lamps I have allotted to this part of the building.

Six hundred and fifty 16-c.p. lamps would absorb 65 h.p. to 70 h p. of energy. It is not, however, at all likely that under any circumstances the whole of these would be alight at once. On the other hand, it is necessary to have some power in reserve to draw upon if at any time anything should go wrong. If we regard the new Town Hall alone, it would be necessary to have two 30-h.p. engines, each with suitable dynamos, installed in the spare engine-house at the waterworks, and a large battery of secondary cells fixed at the new Town Hall. Under ordinary circumstances, it would only be necessary to charge this battery two or three times a week, and trust to it to supply all the lights. On ceremonial or other extraordinary occasions, one of the steam-dynamos could be run to help the battery, or the battery could be held in reserve, and both engines run direct on to the lamps. Heavy main conductors must be laid between the engine-house and the Town Hall.

I do not think it necessary to instal separate boilers for this electric plant. We should do better to utilise either of the two excellent batteries of Cornish boilers you have now fixed to supply steam for your pumping engines that happened to be in use at the time.

I estimate the cost of a separate installation of the Town Hall as follows :

Two 30-i.h.p. steam-dynamos	£800
Steam-pipe connections and fittings	100
Engine-room switches, instruments, etc.	50
Main conductor to Town Hall :	
One 3in. cast-iron pipe line, 350 yards	56
800 yards of cable and sundries	394
One battery of 56 cells (31-plate Crompton-Howell) or equivalent size of other make	400
Racks, insulators, etc., for battery	60
Distributing and regulating switchboard, instruments, connections, etc.	90
Wiring for 650 lamps at 30s.	975
Special metal fittings (approximate)	400
Total	3,325
Add for contingencies (say)	175
Grand total	£3,500

£2,000 of this would be saved if there was a general system of supply to draw from.

The annual cost of this separate installation for the Town Hall would probably be £330.

The Compulsory Area.—It would be practicable to serve the compulsory area and make provision for the eventual extension of the system over the whole borough, from a central station which could be erected at the western or Church-road end of the waterworks yard. Along Church-road runs in a disused sewer a stream of water that will answer excellently for condensing purposes, and thus ensure a high economy in fuel. I am informed that we can count on 400,000 gallons per day as a minimum from this stream, and that during an average day in winter it reaches to 1,000,000 gallons. This would give an ample supply for condensing purposes. I should not propose at first to put in a condensing plant, but to add it afterwards, when the business grows to warrant it. With a large plant the saving in fuel would be not less than 15 per cent., and it might reach to 20 per cent. Its relative value would not be so great with a small plant.

I estimate that, in addition to the lamps to be fixed at the new Town Hall, at least 6,000 lamps of 8 c.p. each will be taken up in the compulsory area alone. You have in this area the cream of the business houses in your borough The shops in North End, High-street, and George-street would probably take 4,000 to 5,000 lamps.

From the foregoing it is evident that we shall have to provide a central station and instal machinery and mains sufficient for the supply of a total of, say, 7,500 lamps of 8 c.p. I estimate the capital cost of doing this as follows:

Buildings	£2,500
Machinery and plant	6,000
Mains	4,500
Distribution, etc.	1,000
Add for contingencies	1,000
Total	£15,000

Revenue.—In my preliminary report I have indicated that electrical energy could not then be produced as cheaply as gas, but subsequent experience and practice has so improved our means of generation that now we can produce it quite as cheaply. I proposed in 1890 that the charge per Board of Trade supply unit should be 7d., and considering the wide and scattered character of your area, I shall not now suggest a lower rate. It is practically equivalent to gas at 3s. 6d. per 1,000 cubic feet, and as gas in your district is 2s. 9d. per 1,000, it means that you will be competing with that source of illumination on nearly level terms.

I estimate the profit and loss account as follows:

Revenue—6,000 lamps at 11s. 8d.	£3,500	
Town Hall lighting	220	£3,720
Working expenses	2,000	
Interest and sinking fund	750	
Cost of Town Hall lighting (actual)	220	
		£2,970
Profit towards reduction of rates		£750

The ultimate revenue and profit to be obtained when the whole of your borough is served would dwarf the figures given above. The receipts will probably reach £20,000 a year, and the profits £5,000 a year.

I very strongly urge the consideration of the larger scheme to supply the whole borough, commencing with plant sufficient to supply only the compulsory area. Nothing can prevent the ultimate adoption of the electric light. The growth has been checked by fear and ignorance—fear of its danger, ignorance of its cost.

Public Lighting.—Fifty arc lamps distributed over the streets of your compulsory area might displace 200 gas-lamps, and provide four times the amount of light given at present. North End, High-street, Crown-hill, and George-street would take 32 of these, as shown on the tracing I attach to this report. If, however, only 20 were fixed in these streets, the light would be immeasurably superior to what it is now. The remainder could be put in other streets where wanted, or the first installation could be confined to 25 or 30 lamps.

The capital cost of this service would be £2,500, and the annual cost £700. Half the lamps could be extinguished at midnight. They would add greater security to traffic and safety to person, and the supervision of premises and repression of crime would be rendered more easy. It has been said in America that every arc lamp saves a policeman. If less than 50 are fixed the cost would be reduced, but not quite proportionately.

Motive Power.—Electrical motive power has one great advantage over all other forms of power. It can be started when it is wanted, stopped when it has done its work, without waste, and the expenditure of energy to the work done is regulated automatically. It is especially applicable for small industries where gas or steam power is out of the question, and its use for home purposes leads us to hope for the revival of the cottage industries of the past.

Conclusion.—I recommend that your Corporation seek power to borrow £20,000 for electric lighting works to be expended as follows:

Generating and distributing plant for compulsory area—

Private lighting	£15,000
Public lighting	2,500
Working capital	2,500
Total	£20,000

This will enable you to provide a thoroughly good service for your compulsory area, to provide the generating plant for your new Town Hall, and to save a considerable amount of the gas bill for the public lighting of your streets.

If your Council adopt this recommendation, the next step will be to draw up a specification and invite tenders thereon. This specification should indicate most clearly and distinctly the needs of your district, the number of lamps to be provided for, etc., and it should be left to the experienced firms who will tender to specify how they propose to meet these needs. This will enable you to profit by the advice of many whose advice is worth having, and it will be impossible to charge the Corporation or its advisers with having framed a scheme that perhaps only one or two of our large contracting engineers could tender to. The chief points to be insisted on in the specification would be: (*a*) The efficiency and continuity of the service; (*b*) absolute security to life and property; (*c*) the possibility of extension to all parts of your district.

If the course I have indicated be followed, I am sure it will give satisfaction to the industry; it will enable the Corporation to arrive at a just and fair conclusion as to what is best to be done in the interests of the ratepayers; and it will enable the ratepayers themselves, in the light of public criticism, to see that their guardians are fulfilling their trust, and are doing what is right and proper.

Councillor Miller introduced the report, mentioning that the site of the proposed station was the waterworks yard.

Councillor Martin argued strongly against spending £25,000 of the ratepayers' money on an electric lighting enterprise, and moved an amendment referring the report back to the committee.

After much discussion, for and against, the amendment to refer the scheme back was carried by the casting vote of the Mayor. The following is the voting.

For the amendment—Aldermen Barrow, Layton, Morland, Rymer, Schmitz; Councillors Allen, S. G. Edridge, Godson, Goodwin, Hillier, Johnson, Joslin, King, Klein, Lillico, Martin, Oelrichs, Price, Shirley, Smith, and Tancock.

Against the amendment—Aldermen F. T. Edridge, Hopekirk, Miller, Pelton, Thrift; Councillors Butler, Perkins-Case, Chapman, Dart, Dobson, Foot, Foulsbam, Hinton, Hobson, Jones, Moss, Peck, Privett, Thompson, Trumble, and Weightman.

Councillor Rigby declared he was neutral.

COMPANIES' MEETINGS.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHTING COMPANY, LIMITED.

The ordinary meeting for 1893 of the above Company was held on Tuesday at the Company's central station, Carnaby street, W., under the presidency of Mr. Eustace J. A. Balfour, chairman. The notice calling the meeting having been read by the secretary (Mr. F. J. Walker),

The **Chairman**, in moving the adoption of the report and accounts, which it was agreed should be taken as read, and which were published in our last issue, said that he thought it would be of interest to the shareholders if he entered into a few matters in connection with the year's working, and with the present position of the affairs of the Company. They might, he remarked, look back upon the past year with satisfaction. There was, it was true, nothing showy or brilliant in the report, and the dividend which they recommended, although not so large as some might have anticipated, yet showed that the business possessed most satisfactory earning power, for it must be borne in mind that in the future they had every reason to suppose that their earnings would increase without any considerable addition of capital expenditure. One of the most curious features of the year was the economy which the consumers had exercised as compared with former years. That might best be shown by noting the relative increase in the gross income from the supply of light and the number of lamps wired. The latter was 24·4 per cent., whilst the former was only 10·4 per cent. Had their gross income increased in proportion to the number of lamps wired, their net earnings would have enabled them to pay a much larger dividend. Looking, however, at the matter broadly, he thought that that was probably a good feature in the business, because he considered that many would-be customers had hitherto held aloof owing to the belief that electric lighting was excessively costly. A very satisfactory feature of the year's working was the saving which had been effected in the cost of production. Thus the consumption of coal had been diminished by ¼lb. per unit sold, whilst that of water had been reduced from 13·6lb. to 11·5lb. per pound of coal. Dealing with those figures, the editor of *Lightning* said: "From these figures it will be seen that Mr. Crompton's 'sheer costs estimate' is more than realised; the total costs show a reduction of ¼lb. per unit, which cannot otherwise be regarded as highly satisfactory and reflecting the highest credit upon Mr. Dobson, the Company's engineer"—a remark with which the Directors cordially agreed. It was their intention to maintain and, if possible, to increase that economy. While on that subject he thought the shareholders should realise that the economical management did not apply to cost of production alone, but also to capital expenditure. In that they compared very favourably with any other of the metropolitan companies: he evidently could not particularise, but their capital expenditure per unit of capacity was satisfactorily low. Those results had only been attained by the most rigid and continuous supervision. They would notice that there had been a considerable reduction in the amount set aside for depreciation of plant and machinery. After careful consideration the Directors had come to the conclusion that the very large expenditure for repairs, maintenance, and renewals justified that reduction, but the putting of depreciation at a just valuation was a matter which would have to be considered each year on its own merits, as the conditions varied. For instance, a few days ago serious damage was done to one of their engines in Mason's-yard through the breaking of a crankshaft. They could not be free from such accidents, which, indeed, must be regarded as inseparable from the wear and tear of their machinery. The Directors regretted extremely the result of the action brought against the Company by Dr. Hopkinson in respect of the three-wire patent, and they were carefully considering what future steps to take in the matter. The idea seemed to have got abroad that their supply could thereby be stopped. That was not the case, as arrangements had been made by which, if necessary, the supply could be continued without further infringement of the patent. They could not at that time go into details. On the 7th of June last four gentlemen, representing some of the founder shareholders (Messrs. Fry, Sturby, and W. G. Kitchen, and Colonel Francis) issued a circular calling a meeting of the founder shareholders to consider certain matters in connection with the management of the Company which they regarded as detrimental to their interests. The Directors, while of course they were bound to consider the interests of the whole body of shareholders only, were anxious to discuss those matters in a friendly way with the representatives of the founder shareholders, and a meeting was consequently arranged between delegates of the two. The first point complained of was that the Directors did not bring forward for division as profit the £2,000 received as premium on 10,000 shares issued in December, 1891, but intimated that they had carried it forward to a capital reserve fund. Now in reference to that complaint he had to note that the Directors, in the prospectus under which those shares were issued, said that the amount derived from that premium would be put to a capital reserve account. It was on that condition, therefore, that the shares were subscribed for. Thus the Directors could not alter the arrangement, if they would. Further, the owners of founders' shares who applied for shares acquiesced in that arrangement, and all had notice, but if those shares had been issued at par, instead of at a premium, the founders would not have benefited. The Directors would in that case have issued 5 per cent. preference shares instead of 7 per cent., but as a sum equal to 7 per cent. on the whole capital of the Company had to be paid before the founders were entitled to receive any dividend, they would have been, as far as that was concerned, in exactly the same position as now, but they would not have had the contingent benefit of a quarter of this £15,000 in case of the winding up of the Company. All classes of shareholders benefited alike by the strengthening of the Company, owing to the existence of the capital reserve fund. The next point raised by the representatives was that an excessive amount had been written off for depreciation. He had already dealt with that subject, and could only repeat that in each year the Directors would do their best to arrive at a just valuation of the amount which should be written off. They were quite at a loss to discover on what grounds the statement in the circular was made. The next objection raised was the special redemption fund. The Directors had carefully considered the representations made to them on the subject, and they felt strongly that the course they had adopted was not only right, but that it would meet with the approval of the shareholders. It would no doubt have been pleasant to divide the £2,000 as profit, but it would not be sound finance. Under the Electric Lighting Acts their property might be, and probably was, a vanishing security; in many ways it resembled an investment in leasehold property. They therefore felt bound to create that fund. In all those matters the Directors had considered the well-being of the Company as a whole, and not one class of shareholders; but even then it was worth noting that in the direction of big profits the interests of founders and of ordinary shareholders were identical, since for every £1 coming to the founder shareholder, a corresponding £1 was handed to the ordinary shareholder. In conclusion, he mentioned that he thought the shareholders would have preferred to come to that building and see for themselves what they were doing there. He would be glad to answer any questions. He then moved the adoption of the report and accounts, and of the dividends to be paid on February 1.

The motion was seconded by **Mr. Latimer Clark, F.R.S.**

Mr. Fry thought that in his remarks about the founder shareholders the Chairman had not completed the story, and he asked him to do so. The speaker was of opinion that that would show the matter in a different light. He wished to know whether any steps had been taken by the Directors for a verbatim report of the proceedings to be taken, and a copy sent to every shareholder. That question had been raised at the last meeting, and the best report he had seen of it was in the *Electrical Engineer*. It was right that every shareholder should have a report of the proceedings. It was done by every company of note, and he thought his fellow-shareholders also considered that their Company was, if not the best, certainly one of the best. Referring to the report, he said that the shareholders must feel a certain amount of disappointment that they had not been able to get on with the construction of that station faster than they had, but it would be more satisfactory to the Directors if the new station had been earning a revenue, because they had practically been paying interest on capital which had been entirely unproductive. With regard to the question of the redemption fund, the Chairman must know that there were such things as rights of the founder shareholders. Those rights were clearly pointed out, first in the memorandum of association, and afterwards in the articles of association, and they intended to test those rights. The ordinary shareholders also had rights, and they were bound up with those of the founder shareholders. If they took into consideration the clauses of the Electric Lighting Acts, and under which powers were given to buy up their concern at the end of the time, he thought it would be apparent to anyone that they were not likely to be bought up for old iron, as the Directors seemed to imagine. Concerning the redemption fund, which was stated in one paragraph of the report as having been carried *nem. con.* at the last meeting, he remarked that, according to the report in the journal before him, there was great opposition to the proposal, and he asked whether the Directors had taken the opinion of eminent counsel on the matter. As regarded the case of the three-wire patent, he would like to know how it was that that system had been adopted, and upon whose advice. He presumed it was possible to determine what were and what were not patents, and he wished for a categorical reply as to upon whose advice the method had been adopted.

Colonel Francis drew attention to the account for depreciation, and to the remark that the founder shareholders had questioned the account of last year as being excessive. The grounds upon which that question arose were these: The solicitor of the Company was applied to in order that he should make a statement as to on what scale the depreciation had been arrived at, and he (the speaker) thought that that was a perfectly fair question. The same question was asked at the meeting, and the report of the solicitor was absolutely at variance with the opinion of the chairman of the meeting at the time. With regard to the meters, some of them had only been in existence for two months, and yet depreciation had been charged for the entire year. They had charged 12 per cent. depreciation; but the best authority on meters had informed him that 5 per cent. was about right, and that in a new concern like theirs the question should not be raised. The main fact, however, remained that depreciation for the entire year had been charged upon instruments which had only been in operation for two or three months. Then again, in last year's report it was stated that machinery had been purchased at the Naval Exhibition; that an excellent bargain had been made; that they had the advantage of laying down machinery which had been tried; and yet depreciation on that had been charged for the whole year when it had also only been at work for three months, and likewise on machinery which had not been used. He thought the shareholders should have the matter explained to them.

Mr. Sams mentioned that in the memorandum of association it was stated that after the various dividends had been paid the remaining profits were to be divided between the ordinary shareholders and the holders of founders' shares. In his simplicity he took that to mean what it stated, but he was afraid that it did not. He bought a share which he thought might bring him 5 or possibly 6 per cent., but he found that he received nothing at all like that. In his opinion, the statement was a mis-statement.

Mr. Foster asked in regard to the redemption fund whether the Directors would refer the matter to arbitration. He would like to have the sense of the meeting as to whether that should be done, or whether great expense was to be incurred in litigation.

The **Chairman**, in reply, said that Mr. Fry had asked him to tell the whole story of the negotiations between the Directors and the holders of founders' shares. He read the letters referred to, and mentioned that after the opinion previously expressed by the Directors, they did not see how they could have agreed to submit the questions at issue to arbitration. If, however, the meeting decided that the matter should go to arbitration, they would be bound by that decision. With regard to the suggested verbatim report, if it was strongly put to the meeting, the Directors were prepared to fall in with their views on the matter. The new station had been pushed on as rapidly as possible considering the many difficulties which had to be surmounted. The next point was the purchase of the concern at the end of 42 years. That was a very complicated question, and the Directors, although they had not taken definite legal opinion, had constantly discussed the matter. They did take the view that nothing would be paid for goodwill by the local authority, and that all they would get, as Mr. Fry had put it, would be the price of old iron. Mr. Fry had asked them to reconsider their position on the matter of the redemption fund, and his answer to that was that if it was the wish of the shareholders as a body that they should put it to arbitration, they would do it. With reference to the three-wire patent, the view of the Directors at the time of adopting the system was that it was not a patent, and there were many scientific men who still held that the decision of the judge was not in accordance with the facts of the case.

Colonel Francis said that Mr. Latimer Clark had assured him that he or his firm possessed whatever rights there were under the three-wire system. Confirmation of that statement was to be found not later than last Saturday, when Mr. Latimer Clark advertised that his firm designed the patent system used by the Company.

The **Chairman** said that as chairman of the Company he was prepared to accept all responsibility with regard to the action taken in connection with the three-wire patent, but he protested against a former chairman of the Company getting up and shirking the responsibility which he himself should take.

Colonel Francis repeated that Mr. Latimer Clark and his partners also had informed him over and over again that they possessed those rights. He said that he would confirm that by referring them to the way in which they advertised that they were the designers of the system.

Mr. Latimer Clark said it was incorrect to speak of him as a firm, as the concern had been a limited company for many years. When the St. James's and Pall Mall Company was formed he joined as a director, and not as a scientific expert. As to what Colonel Francis had said about his company owning the three-wire system, that referred to the ordinary culvert system and the details of practically carrying it out. Whatever rights they had referred to the culvert and not to the three-wire system. They brought to the Company the knowledge that there was such a patent, but he could not remember that they said that they had any rights in the matter

The **Chairman**, in continuing his reply, stated that at the interview at which Mr. Fry attended on those little differences, the Board suggested that if those at variance would give to the Directors the name of a gentleman who had the qualification to serve as a director, and who was friendly with the holders of founders' shares, they would be glad, if he was a suitable person, to receive him on the Board. The Directors had, however, had not heard anything further in the matter, and he thought the shareholders would agree that the Board could not have gone any further. Mr. Cotterell had sent up a question as to how far the economy realised during the past year and the low capital expenditure were due to the supply on the three-wire system. Well, they did not admit economy over one or the other. They were under the impression that they could have had a similar system which avoided the patent altogether. Another question was as to what were the specific arrangements contemplated for carrying on the lighting without infringing any patent not purchased by the Company. He did not think it advisable to enter into technical details on that point; they were still in negotiation on the subject, and, moreover, it was inadvisable to make the arrangements public. Mr. Kirby (vice-chairman) had just reminded him that they were apparent defendants in the recent action; they were simply the first company attacked, the fight being on joint costs with other companies. It was the opinion of all the companies that the patent was no good.

Mr. Cotterell had read since the decision in the Law Courts all the available scientific material, and he was afraid that any system which approached in any remote degree the three-wire system would constitute an infringement. Now he gathered from the Directors' report that the remarkable economy was due to the arrangements under which the light had been supplied on that system. If they adopted any other system they would tread upon unknown ground, and they might not realise anything like the same results as before. That, too, might lead to further infringement, and he thought the Directors should enlighten them on the matter.

The **Chairman** observed that he would have been glad to impart the information, but he thought it would not be advisable for the benefit of the Company to do so. He must respectfully beg not to answer the question. In reply to Colonel Francis, he had already explained in his speech the method upon which they intended to calculate the depreciation, and it was unnecessary to repeat it. With regard to meters, he was informed by Mr. Clark that they were going out of use. A report of the proceedings would be supplied to the shareholders. In conclusion, he begged to put to the meeting the resolution which had already been read.

The motion was carried by a majority of 24, 31 voting for and seven against it.

The retiring Directors, Mr. E. J. A. Balfour and Sir John H. Morris, K.C.S.I., were re-elected.

Colonel Francis asked, after what the Chairman had said in his speech, whether he intended to take the sense of the meeting on the question of litigation or arbitration. He then moved, "That the question between the founders and the Directors with regard to putting aside of a redemption fund as it affects the interests of the founder shareholders, should be submitted to arbitration."

Mr. Foster seconded the resolution.

Dr. Webb moved as an amendment that "this subject should be left to the trusted guardians of our interests– that is, our Directors." He considered that the question was one which could safely be trusted to them, and from what he had heard that day he felt more confidence in the Company.

Mr. Bourn seconded the amendment.

This was put to the meeting and was carried by a majority of 19.

The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were re-elected, and a vote of thanks to the Chairman brought the proceedings to a close.

COMPANIES' REPORTS.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY.

Directors: Alderman T. G. Gibson, J.P., chairman; Dr. Robert Spence Watson, Dr. J. T. Merz, Colonel F. F. Sheppee, M. W. Lambert, Esq., J. Tennant, Esq., J. H. Armstrong, Esq.

Report of the Directors to be presented to the fifth general meeting of the shareholders.

The Directors have pleasure in presenting the balance-sheet and profit and loss account for the year ended December 31, 1892. The amount of share capital subscribed amounts to £29,920, on which £25,699 has been paid. Besides this, £15,000 has been raised on debentures. The profit and loss account shows a gross profit of £2,300. 5s. 1d., which is reduced to £1,311. 19s. by payment of £988. 6s. 1d. for interest on debentures and on calls in advance. This, added to the amount brought forward—viz., £364. 13s. 3d.—makes a total of £1,676. 12s. 3d. to be disposed of. Out of this sum the Directors propose the payment of a dividend at the rate of 4 per cent. per annum, less income tax, payable on the 1st February, which, on the capital as paid during 1892, will absorb £895. 13s. 5d., leaving a balance to be carried forward of £780, 18s. 10d. Out of this amount the Directors recommend that a sum of £600 be carried to a reserve fund to meet any depreciation that may arise on the Company's assets. The retiring directors are Mr. James Tennant and Dr. R. S. Watson, who offer themselves for re-election. The auditor, Mr. Thos. Harrison, also retires.

BALANCE-SHEET, DECEMBER 31, 1892.

Liabilities.	£	s.	d.	£	s.	d.
Nominal capital—10,000 shares of £5 each	50,000	0	0			
Issued and allotted—5,984 shares at £4 per share called up	23,936	0	0			
Add calls paid in advance	1,763	0	0			
				25,699	0	0
6 per cent. mortgage debentures				15,000	0	0
Creditors—On sundry accounts	2,175	14	4			
Bank overdraft	510	5	4			
				2,685	19	8
Profit and loss account as at December 31, 1891	1,006	8	7			
Less dividend at 4 per cent. per annum, for year ending December 31,1891	641	15	4			
	364	13	3			
Add profit for year to date	1,311	19	0			
				1,676	12	3
				£45,061	11	11

Assets.	£	s.	d.	£	s.	d.
Capital expenditure—						
Buildings and plant as at December 31, 1891	29,427	5	2			
Additions to date	4,894	16	8			
				34,322	1	10
Meters, transformers, etc., as at December 31, 1891	4,159	17	1			
Additions to date	1,122	6	6			
				5,282	3	7
				39,604	5	5
Loose plant and tools as at December 31, 1891	294	19	6			
Additions to date	74	0	5			
				368	19	11
Office furniture as at December 31, 1891	104	15	8			
Additions to date	1	15	0			
				106	10	8
Preliminary and formation expenses as at December 31, 1891	654	3	8			
Further expenditure to date	172	6	0			
				826	9	8
Stock and work in progress				1,728	9	4
Debtors—On current supply	1,419	2	5			
Sundry debtors	918	4	8			
				2,337	7	1
Cash in hand				89	9	10
				£45,061	11	11

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Station charges—Salaries, wages, coal, water, and maintenance				2,789	10	8
Street charges—Salaries and maintenance				492	0	6
Rent, rates, taxes, and insurance				280	13	11
General charges—Directors' remuneration	£131	5	0			
Office salaries, legal and accountancy charges, stationery, stamps, telegrams, etc.	218	16	4			
				350	1	4
Balance carried down				2,300	5	1
				£6,212	11	6
Interest—On debentures	£907	0	6			
On calls paid in advance	81	5	7			
				988	6	1
Balance carried down				1,311	19	0
				£2,300	5	1

Cr.	£	s.	d.
Current supply	5,606	14	2
Public lamp supply	56	2	0
	£5,662	16	2
Apparatus rent	525	6	4
Profit on sale of lamps	22	15	6
Transfer fees	1	13	6
	£6,212	11	6
Balance brought down, being gross profit for year	2,300	5	1
	£2,300	5	1
By balance, being profit for the year	1,311	19	0

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald Lodge, Stanmore; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq, 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the Directors for the half-year ending December 31, 1892, to be submitted to the seventeenth ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on February 1, 1893, at 3 p.m.

The receipts from all sources for the past half-year have amounted to £22,652. 13s. 11d., and the cost of working has been £15,389. 17s. 2d., leaving a profit of £7,262. 16s. 9d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £8,304. 12s. 2d. After making provision for the debenture and debenture stock interest, amounting to £4,258. 19s. 2d., a balance remains available for dividend of £4,045. 13s. Out of this sum your Directors recommend the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of ⅝ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £822 to be carried forward to the next account. The number of passengers conveyed during the six months ended 31st December, 1892, exclusive of season-ticket holders, was 3,217,602, showing an increase over the corresponding period of the previous year of 468,547. Your Directors have satisfaction in reporting that the service of trains has been carried on during the whole of the half-year with great regularity, and with an almost entire absence of any interruptions whatever, while the receipts from traffic have increased considerably. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	No. of passengers.	Receipts, including season tickets. £	s.	d.
December 31, 1890 (11 days) about...	165,000	1,568	3	9
June 30, 1891	2,412,343	19,403	6	9
December 31, 1891	2,749,055	19,798	16	6
June 30, 1892	2,813,162	20,931	4	2
December 31, 1892	3,217,602	22,002	17	5
Total since the opening of the line...	11,357,162	£83,704	8	7

By the appended certificate of the engineer, it will be seen that the locomotives, rolling-stock, and generating plant have been efficiently maintained and are in good working order. Difficulties with the local authorities have delayed the commencement of the much-needed siding accommodation at Stockwell Station, forming part of the Clapham extension line, but it is hoped that these works will very shortly be started. The conversion of the terminal debentures into either 4 per cent. perpetual debenture stock or 5 per cent. perpetual preference shares is progressing satisfactorily, and will result in a considerable saving of interest to the Company. A resolution for the conversion into consolidated ordinary stock of the remaining 3,000 ordinary shares already issued, will be submitted to the special meeting to be held at the conclusion of the half-yearly meeting. It is anticipated that the Bill promoted in the last Parliament by this Company for the extension to Islington and other purposes, will be proceeded with immediately after Parliament assembles. A Bill to extend the time for the purchase of lands under the Act of 1890 (Clapham Extension), and for other purposes, has been deposited in Parliament for this session. The Directors retiring by rotation are Messrs. Charles Seymour Grenfell and Edwin Tate, who are eligible for re-election. The auditors retiring are Messrs. Turquand, Youngs, Weise, Bishop, and Clarke, and they offer themselves for re-election.

REVENUE ACCOUNT.—Half-year ending December 31, 1892.

Dr.	£	s.	d.
Maintenance of way, works, and stations	389	18	9
Locomotive and generating power	6,348	4	8
Carriage repairs	416	13	10
Traffic expenses	6,052	7	11
General expenses	1,632	3	0
Law charges	75	0	0
Compensations	65	17	0
Rates and taxes	409	12	0
	15,389	17	2
Balance carried to net revenue account (No. 10) ...	7,262	16	9
	£22,652	13	11

Cr.	£	s.	d.
By passengers (3,217,602)	21,462	7	4
Season tickets, 289	540	10	1
	22,002	17	5
Parcels, etc.	14	12	10
	22,017	10	3
Transfer fees	9	10	0
Rent of property	562	9	8
Sundry receipts	63	4	0
	£22,652	13	11

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
Balance from revenue account, No. 10	4,045	13	0
Unpaid interest	79	12	10
Interest payable or accruing and provided for	1,346	10	0
Sundry outstanding accounts	22,158	2	9
Lloyd's bonds (since paid)	1,000	0	0
Construction reserve	2,658	19	1
	£31,288	17	8

Cr.	£	s.	d.
Cash at bankers, current accounts	2,346	7	8
Cash in hand	248	15	11
	2,595	3	7
General stores	2,923	2	6
Sundry outstanding accounts	598	2	5
Islington extensions, parliamentary, etc., expenses	4,011	11	6
Parliamentary deposit, 1890 Act	7,071	13	0
Balance from capital account, No. 4	14,089	4	8
	£31,288	17	8

NEW COMPANIES REGISTERED.

Weldless Chain Company, Limited.—Registered by Lake, Beaumont, and Lake, 10, Lincoln's-inn, W.C., with a capital of £100,000 in £10 shares. Object: to acquire certain inventions, patents, etc., relating to the manufacture, improvement, and treatment of chains, cables, etc., weldless or otherwise; and, with a view to such acquisition, to carry into effect an agreement, made January 9, between J. B. Atherton of the one part and this Company of the other part; and to carry on in all their respective branches the businesses of chain and cable manufacturers, iron and brass founders, electrical and general engineers, ironmasters, colliery proprietors, etc. The first signatories are:

	Shares.
G. J. Snelus, Ennerdale Hall, Frisington, Cumberland	1
S. Revington, Kilmeny, Wimbledon, S.W.	1
J. Beecham, Ewanville, Highton, Lancashire	1
J. Forster, Cowley Hill, St. Helens, Lancashire	1
J. B Atherton, Manhattan, Rainhill, Lancashire	1
J. Atherton, Mayfield, Highton, Lancashire	1
P. W. Church, Kilmeny, Wimbledon, S.W.	1

The first directors—to be not less than three nor more than nine—are George J. Snelus, S. Revington, Joseph Beecham, J. Forster, and J. B. Atherton. Qualification, £500. Remuneration, £100 each and percentage of the profits.

Bailey, Grundy, and Barrett, Limited.—Registered by Waterlow Bros. and Layton, Limited, Birchin-lane, E.C., with a capital of £10,000 in £5 shares. Object: to acquire the business of electricians now carried on under the style of Bailey and Grundy, at Cambridge, in accordance with an agreement expressed to be made between R. M. Bailey of the one part and this Company of the other part, and to develop and extend the said business in all its branches. Directors to be not less than two nor more than seven; to be elected by the signatories to the memorandum.

BUSINESS NOTES.

Trolley System.—The use of the trolley has just been authorised in Philadelphia.

Barnard Castle.—A new scheme of lighting the town of Barnard Castle is to be prepared.

Lyons.—The horse cars at Lyons are to be replaced, it is stated, by Thomson-Houston electric cars.

Newbury.—Mr. R. A. Soper writes to the Newbury local paper to press on the electric lighting of this town.

Nottingham.—The Corporation of Nottingham are inviting tenders for boilers for their central electric station.

Calendar.—We have received a calendar for 1893 from Messrs. George Skudder and Co., oil refiners, of 98, Tooley-street, London Bridge.

Reading.—The Corporation of Reading have consented to the granting of a provisional order to the Reading Electric Supply Company.

Bilston.—The market stall-holders at Bilston do not seem to appreciate the electric light there, to judge from their petition for more light.

Draughtsman.—An opening for the responsible position of chief draughtsman in an electrical works will be found in our advertisement columns

St. George's-circus.—The London Electric Company have obtained permission to erect an arc lamp on the obelisk at St. George's-circus.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,653.

Melton.—The committee of the Suffolk Joint Councils Committee have resolved that an electric automatic indicator be provided at the waterworks, as suggested by Mr. Hodson.

African Telegraph.—The construction of the telegraph line which is to connect Beira with Fort Salisbury, and so place us in communication with the whole world, is about to be commenced.

Bury.—Letters advocating the speedy introduction of electric light appear in the *Bury Guardian*. It is suggested that the waste heat from the gasworks retorts should be utilised as at Nelson.

Rouen.—The electric station at Rouen has been quite successful. Since 1890 the number of customers has increased from 212, to 479 in 1892, with 5,600 lamps. There is 15 miles of mains laid.

Hull.—The Hull Corporation are starting an interesting experiment by advertising for "improvers" in their central station, at a premium of £30. Candidates must have had experience in college or workshop.

Britannia Telegraph Works.—Mr. Alfred Whalley informs us that in addition to the work of electrical engineer to the Telegraph Manufacturing Company, of Helsby, he has accepted the secretaryship.

Fire Brigade Stations.—The London County Council are intending to erect a fire brigade station at Rotherhithe. There will be some electric alarm apparatus required. A fire station will also be erected at West Ham.

New Olympia—Imre Kiralfy is to erect an immense hall of his own near Charing Cross for the gigantic displays with which his name is familiar. Electric light occupies a large part in these displays, and will certainly be required.

Utilisation of Refuse.—The Hammersmith Vestry have instructed their Electric Lighting Committee to consider the desirability of making experiments in the utilisation of refuse destructors for the generation of electric light in the parish.

Coatbridge.—At the Coatbridge municipal meeting last week, it was agreed that, pending the introduction of electric light to the buildings, enquiries being still in progress, that in the meantime gas pipage be introduced, at a cost of £150.

Epsom Telephones.—Mr. Morton, representative of the National Telephone Company, has informed the Epsom Local Board that their decision not to allow overhead wires will probably prevent the company coming to Epsom at all.

Edinburgh Deputation.—Councillor Waterston, in his address to the Liberal Committee, stated the recent deputation has cost £200, which he thought was too much, though the ratepayers were promised a great deal as a result. A guinea a day ought to be sufficient.

Hove Town Hall.—The Town Commissioners of Hove have appointed Mr. Frank King, of the firm of Messrs. Morgan Williams and King, of 39, Victoria-street, Westminster, to advise them in the matter of the tenders on the electric lighting of the Town Hall.

Aberdeen.—Mr. M'Whirter, of Glasgow, who has been superintending the installation at the Palace Hotel, Aberdeen, has recently made experiments with the view of introducing electric light into the Denburn Valley. It is proposed to light the railway station first.

Lamp Patents.—The Edison and Swan United Electric Light Company, Limited, announces that the statements made in the circulars of foreign lampmakers which are now being circulated in this country, to the effect that its lamp patents are now at an end, is incorrect.

Oxford University.—The Bodleian Curators of the University of Oxford have instructed Mr. Morgan Williams, of the firm of Messrs. Morgan Williams and King, of 39, Victoria-street, Westminster, to report on the proposed electric lighting of the buildings under their control.

Edinburgh.—The report of the deputation, which we give elsewhere, was remitted to the committee at the Edinburgh Town Council meeting on Tuesday to decide whether the city authorities were to hand the powers over to a company or to carry out the installation themselves.

City and South London Railway Company.—The receipts for the week ending January 22 were £973, against £811 for the corresponding period of last year, or an increase of £162. The total receipts for 1893 show an increase of £473 over those for the corresponding period of 1892.

Micanite.—The artificial mica, called micanite, is composed of pure India sheet mica and the least possible amount of cement (of high resistance) required to hold the films together. It is used for armature insulation and other purposes, and is manufactured by the Mica Insulation Company, of Schenectady, United States.

South African Cables.—The Eastern Telegraph Company state they have resumed communications with South Africa. Communication *viâ* the East Coast to Natal was made on Wednesday night, and to Cape Town *viâ* the West Coast early Thursday morning. It is not yet known to what cause the accidents were due.

Bournemouth Pier.—At the Bournemouth Town Council last week, Councillor H. Moore (chairman of the Lighting Committee) stated that the contract for lighting the pier had been given to Messrs. Goddard, Massey, and Warner, which firm was one of the six recommended by the expert whom the Council had consulted in the matter.

Hull.—The central station at Hull (just opened) contains two 200-h.p. and two 80-h.p. engines, each attached to a dynamo, from which a pressure of 110 volts will be obtained, though, when necessary, 115 to 120 volts can be reached. The outlay on the works has amounted to £23,072, and the plant is capable of supplying about 5,000 16-c.p. lamps.

Newcastle Units Sold.—We have received the balance-sheet of the Newcastle Electric Supply Company to December 31st, which we give elsewhere. The following is the statement of the units metered for the year: Private consumers, 330,838; public lamps, 4,303; used at works, 11,687; total, 346,824 supply units.

Havre Electric Tramway.—The electric tramway from the Havre Pier to the Place de Montvilliers will be divided into five zones, at 15 and 10 centimes per zone. Return tickets will be given with 10 per cent. reduction in one zone, 15 per cent. for two, and 20 per cent. for three or more. M. Pierre Burton, who has the concession, pays 6,000f. a year for royalties.

Cadeby Mines.—After sinking operations extending over three and a half years, coal has been reached at Cadeby, a mile from the well-known Denaby main. When fully employed, the new mine will employ 2,000 men. Roadways are being commenced at once. An electric plant for 2,000 lamps is being installed, and a new branch of the railway is being proceeded with as fast as possible.

Torquay.—At the last Town Council meeting at Torquay, a report was presented by the Electric Lighting Committee recommending that offers be invited from companies for the powers under the provisional order. The Mayor moved the adoption of the report, but an amendment was moved by Mr. Harrison, and carried, that the report be referred back to the committee with instructions to call in an expert to advise them on the matter.

York.—The York City Council on Monday had before them a report of a sub-committee that 17 tenders had been received for the electric lighting of the city, and the committee stated that they desired the assistance of an electrical expert. They recommended the Council to retain the services of Prof. Kennedy, of Westminster, as consulting engineer at a salary of 105 guineas. Prof. Kennedy is at present advising the Corporations of Glasgow, Belfast, Aberdeen, and Oldham. The report was adopted.

Coventry.—At the quarterly meeting of the Warwickshire County Council on Tuesday, the Marquis of Hertford presented the report of the County Roads Committee, which recommended, amongst other things, that the Coventry and District Tramways Company be required to relay and equip their line for electric traction forthwith, and that in default of steps satisfactory to the county surveyor being taken with this object within two months, that the attention of the Board of Trade be drawn to the matter.

Concert.—The second annual *conversazione* of the New Telephone Company's Manchester district was held at the offices, 102, Portland-street, last Friday evening. Mr. Valentine officiated as chairman. There was a large attendance of employés and friends, and a very enjoyable gathering was brought to a successful termination in the early hours of the morning. A long and varied programme of vocal and instrumental music was effectively rendered, and the few dances which were interspersed added to the enjoyment.

The Regulation of Electric Light Meters.—In the Westminster County Court, on Wednesday, the case of the Metropolitan Electric Light Company *v.* Nathan came before Judge Bayley. Plaintiffs claimed £3. 17s. 6d. for 128 units of electricity supplied. The defence was that the amount charged for was more than was consumed. Plaintiffs said under their Act of Parliament the meter index was conclusive. Whatever the meter registered the consumer was liable for. Judgment was given for the plaintiffs for the amount claimed, with costs.

St. Helens.—At the meeting of the St. Helens Town Hall Committee last week, the chairman referred to the complaints about the smoke issuing from the chimney over the electric-light boiler at the Town Hall, and said that efforts would be made to abate it as much as possible until the Gas Committee took over the electric lighting of the whole borough. The surveyor explained that when the Gas Committee took over the entire work the Town Hall could be supplied by the mains from the gasworks, and the present engine at the Town Hall would be disused.

Upper Norwood.—The General Purposes Committee of the Croydon Town Council reported at the last meeting that they had considered a draft license submitted by the Crystal Palace District Electric Supply Company, giving the company power to supply the triangle formed by Westow-hill, Westow-street, and Church-road, Upper Norwood, upon the conditions as to purchase by the Corporation, agreed to at the Council meeting of June 27, 1892. The committee recommended that the necessary formal resolution be passed approving of the application for the license. This was approved.

Glasgow.—The electric lighting of those streets in Glasgow that come within the scope of the scheme will be begun, it is expected, in a fortnight or three weeks' time. In Sauciehall-street a number of the lamp pillars have been erected. A preliminary trial was made last week in the new electric-lighting station in Waterloo-street of four engines and dynamos, steam being put on in three of the boilers; the operation was in every respect satisfactory. Among the company present being the Lord Provost, Councillor Burt (convener of the Sub-Committee on Electric Lighting), and Prof. Kennedy.

Ipswich.—At the last meeting of the Ipswich Paving and Lighting Committee a notice was read from the Board of Trade that from January 17th, 1893, the Electric Lighting Order of 1891 would be rescinded. In answer to Mr. Brand, the Town Clerk said the time had gone by for an application to be made for an order by anyone else before he received any intimation from the Board of Trade. There was one gentleman on the Corporation who asked to be advised as to the proper time to take steps, and he wrote to him acquainting him with the proper dates, but he said his hands were too full and the matter must drop for a year. The local authority certainly could not supply electricity without an order.

Westinghouse Lamps.—The Westinghouse Company will begin to supply their new lamps in a few days. The new lamps are made in separable parts, so that the filaments can be replaced and the glass parts used again. The carbon is preserved by an attenuated atmosphere of nitrogen, the candle-power being maintained more constant. The cost will be 1s. 1½d. each new, with discount for quantity, and an allowance of 5d. each for every burnt-out lamp returned unbroken, making renewals of 10-c.p. and 16-c.p. lamps 8½d. each net, and 20-c.p. and 25-c.p. lamps 10½d. each net. They are arranging for an output of 15,000 to 20,000 per day, and "renewal factories" will be established in several large towns. The company are receiving orders in lots as high as 50,000.

Chateau-Chinon.—The authorities of Chateau-Chinon, France, have decided to utilise the River Yonne at Sur-le-Chateau for lighting the town and the distribution of power. A reservoir of 1,000 metres cube will be constructed, and a canal 200 metres long will be constructed to Pré-de-Bouture. The water has a fall of 230 metres. The contractors will have a monopoly for 25 years. They must supply the town with 100 16-c.p. lamps for the streets, and 150 metres cube of water a day for the fountains and standpipes. They have the privilege of supplying private persons with lamps and water, and must state the prices (1) for lamps, (2) for water, (3) for the public lamps, 100 16 c.p. The sites are of insignificant value. Projects are to be sent in by February 28 next.

Irvine.—Another inspection of the Burgh Mill, Irvine, was made last week, at the desire of the Corporation, with the idea of lighting the town by electricity. Mr. Carrick, of the firm of Messrs. Carrick and Ritchie, Edinburgh, patentees of the Waverley turbine, accompanied by a representative of the firm of Messrs. Anderson and Munro, electrical engineers, Glasgow, visited the mill, with the view of calculating the water power and other power available. Mr. Carrick expressed the opinion that with the steam and water power presently at command a current might be obtained sufficient to supply 40 and 50 arc lamps for the town-lighting. Alternative schemes were discussed, including one to supply also private incandescent lighting. A report as to the method and cost is to be supplied to the Town Council on an early date.

Berwick Telephones.—At a public meeting held in Berwick Town Hall on Monday, under the presidency of the Mayor, it was unanimously agreed that it was desirable to have Berwick connected with the trunk telephone lines of England and Scotland. The nearest English trunk is at Morpeth, while Kelso has the Scottish trunk closest to Berwick. Mr. Clay, manager of the National Telephone Company, attended the meeting, and stated that £3,000 or £4,000 would be the smallest cost for a suitable line from Berwick for the south district. He added that negotiations were proceeding between the Post Office and the Telephone Company relative to the acquirement by the Government of the trunk lines, but at the present moment nothing definite had been settled. He anticipated that the matter would be disposed of very shortly after the assembly of Parliament.

Proposed Extension at Hull.—A meeting of the Hull Corporation Electric Lighting Committee was held on the 19th inst., Dr. Holder in the chair. Dr. Kessen moved, "That, in the opinion of this committee, it is desirable that the present station and plant should be utilised to its fullest extent, and the systems of mains and the supply of current extended. That with this view the electric engineer be requested to prepare an estimate of the cost of carrying distributing-mains in continuation of the present mains through the Whitefriargate Bridge culvert to the furthest point of supply, and that upon such estimate being submitted to be approved by the committee, they be authorised to advertise for tenders for the execution of the necessary work." Mr. Newmarch moved that the electrical engineer report upon the advisability of extending the system to the principal streets adjoining the Old Town. The proposition was carried unanimously.

Eastern Telegraph Company, Limited.—The report for the half-year ended September 30th shows that the revenue amounted to £352,391, from which are deducted £98,797 for the ordinary expenses and £37,636 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £4,927 for income tax, there remains a balance of £211,029, to which is added £661 brought from the preceding half-year, making a total available balance of £211,690. From this balance there have been paid interest on debentures and debenture stock, dividend on preference shares, and two interim dividends of 2s 6d. per share each on ordinary shares, leaving a balance of £62,942, which is carried forward to the next account. The revenue includes £33,431 dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

Johnstone Conduits.—We had occasion in our series of articles on "Underground Mains" to describe the Johnstone system of conduits which is being introduced here by the International Electric Subway Company, of 39, Victoria-street. This system is now being laid for the first time in this country by the City of London Electric Light Company for their mains at the back of Salisbury-court and Fleet-street, in John Carpenter-street leading to the Guildhall School of Music. Several hundred miles of this conduit have been laid in America with satisfaction, and the adoption of it by the City of London Company will be noted with interest. The system is essentially iron troughs in two halves, with grooved edges fitting into each other, set in putty, and clamped, the ducts being formed of sliding shelves of iron, with partitions to separate the insulated cables which are laid therein. The advantages of the system are ease of running, inspecting, and exchanging, or adding to the cables. To repair a fault or inspect the cables the lid of the conduit can be easily raised, giving access that is impossible with iron pipes or bitumen conduits.

Rotterdam.—The municipal authorities of Rotterdam recently invited tenders for the establishment of a central electric light and power station for lighting 3,500 incandescent lamps and driving eight electric cranes, and the swingbridge over the Meuse. The following tenders have been received:

Compagnie Continentale Edison, Paris..	1,400,000f.
Société Transmission de la Force, Paris	1,300,000f.
Thomson-Houston Company, Hamburg	1,125,000f.
Crompton and Co., London	1,040,000f.
Schuckert and Co., Nuremberg	890,000f.
Siemens and Halske, Berlin, No. 1.	826,000f.
,, ,, No. 2.	720,000f.
,, ,, No. 3.	626,000f.

The second scheme of Siemens and Halske has the best chance of acceptance after certain modifications, which will bring it up to 825,000f. It is already thought of extending the proposed scheme to 6,000 lamps and 15 cranes. For this scheme the total cost will be 2,800,000f.

Anglo-American Telegraph Company.—The total receipts from July 1 to December 31, 1892, including the balance of £954. 17s. 11d. brought forward from last account, and a sum of £1,619. 16s. 9d. transferred from the interest of renewal fund securities, amounted to £164,365. 11s. 3d. This sum, however, is subject to revision, as the law-suit between this Company and the Paris and New York Telegraph Company is still pending before the Court of Appeal. The traffic receipts show a decrease of £4,670 as compared with the corresponding period of last year, but the total for the year 1892, as compared with 1891, shows an increase of £5,365. The total expenses of the half-year, including repair of cables, etc., as shown by the revenue account, amount to £58,628. 7s. 6d. Interim dividends of 12s. 6d. per cent. on the ordinary stock, and £1. 5s. per cent. on the preferred stock, were paid on November 1 last, absorbing £43,750, leaving a balance of £61,987. 3s. 9d., out of which the directors recommend the proprietors to declare final dividends of 17s. 6d. per cent. on the ordinary stock, and £1. 15s. per cent. on the preferred stock, amounting to £61,250, making a total distribution for the year ended December 31, 1892, of £2. 15s. per cent. on the ordinary stock, and £5. 10s. per cent. on the preferred stock, leaving £737. 3s. 9d. to be carried forward to the next account.

Direct United States Cable Company.—The report of the directors states: "The half-year's revenue, after deducting outpayments, amounted to £43,629. 6s 1d., as compared with £45,402. 0s. 8d. for the corresponding period of 1891, being a difference of £1,772. 14s. 7d. against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,982. 3s. 7d., leaving a balance of £24,647. 2s. 6d., as the net profit, making, with £3,730. 8s. 1d. brought forward from the previous half-year, a total of £28,377. 10s. 7d. For the corresponding period of 1891, the working expenses and other payments amounted to £17,672. 16s. 5d. Interim dividends of 3s. 6d. per share for the quarter ended September 30, 1892 (paid October 24, 1892), and of 3s. 6d. per share for the quarter ended December 31, 1892 (payable January 28, 1893), together amounting to £21,248. 10s., have been declared, and, after setting aside £4,000 to the reserve fund account, the balance of £3,129. 0s. 7d. on the revenue account has been carried forward. During the period under review, repairs have had to be made in both sections of the Company's cables, at a cost of £6,301. 15s. 2d., which has been debited to the reserve fund account as heretofore, the balance of which, with the above addition, stands at £260,298. 6s. 1d."

City Lighting.—The City of London Electric Lighting Company give notice that, unless prevented by unforeseen circumstances, electric energy will be laid on within the next few months in the areas specified below. Consumers will be connected up in the order of application, provided they are ready to receive current when the company is ready to supply. To enable the company to make timely provision, all applications should be sent in as early as possible. The company will not guarantee to supply within these areas during the present year unless applications be made before the 31st March next. 1. Nicholas Cole Abbey sub-area, bounded on the—N. by St. Paul's-churchyard and Cannon-street; E. by Friday-street and Bread-street-hill; S. by River Thames; W. by St. Andrew's-hill and Creed-lane. 2. Finsbury-circus sub-area, bounded on the—N. by South-place, Eldon-street, and Liverpool-street; E. by Bishopsgate-street Without; S. by London-wall and Wormwood-street; W. by Finsbury-pavement. 3. Salisbury-square sub-area, bounded on the—N. by Fleet-street; E. by New Bridge-street; S. by the Embankment; W. by the City boundary. 4. Billiter-avenue sub-area, bounded by—Leadenhall-street, Fenchurch-street, and Gracechurch-street. 5. Farringdon-street sub-area, bounded on the—N. by Holborn-viaduct; E. by Old Bailey; S. by Ludgate-hill; W. by St. Bride-street, Shoe-lane, and St. Andrew's-street. A further list of sub-areas will shortly be issued.

Manchester.—The central installation at Manchester is being vigorously pushed forward, and will be ready for starting in a few months. The engines are being made by Galloways, Limited. They consist of four distinct compound vertical engines, each having a high-pressure cylinder 17in. in diameter; low-pressure 34in. diameter, with a stroke of 3ft. The pistons from these cylinders work on to crank-pins, placed at each end of a crankshaft, which carries the flywheel acting as a pulley, being turned and crowned for receiving the link-belt which transmits the power direct to the dynamo. As the dynamos will be in close proximity to the engines, jockey-pulleys are provided for the purpose of maintaining the requisite tension on the belt. The engine cranks being at right angles, a receiver between the two cylinders is necessary, and both cylinders, with this receiver, are steam-jacketed, the steam from the jacket being derived from the boilers direct. The engines are specially adapted for steady running, the governing being effected by Galloway's patent high-speed parabolic governor, specially arranged so that its sensitiveness and speed can be easily altered while the engines are in motion. It is intended to work the engines at a pressure of 120lb. on the square inch, and they will develop 400 h.p. each when running at a piston speed of 500ft. per minute. They can be run at a more rapid speed if required. The steam is condensed, not by the ordinary jet or surface arrangement, but by Korting's ejector condensers placed in close proximity to the engines. These ejectors are supplied from a tank fixed over the boiler-house, which will be charged from the canal which abuts on the generating yard near Portland-street by means of powerful centrifugal pumps worked by independent engines, the fall of the water condensing the steam, and all being carried away without the necessity of an air-pump. The steam for the engines will be furnished by six large boilers, also constructed by Galloways, Limited. These boilers are made of steel, to work at 125lb. pressure, and are provided with the most improved fittings, including Vicars's mechanical stokers. The entire ranges of steam and feed pipes are duplicated, so that under no possible combination of circumstances can all the boilers or engines be simultaneously rendered inoperative. The steam-pipes are 18in. in diameter, and are all of wrought steel, welded, with strips double-riveted over the weld—a new departure in pipe construction.

Dundee.—At a meeting of the Dundee Gas Committee on Monday it was reported that the city would be illuminated with electric light in the course of a fortnight. The works, it was stated, had been greatly retarded by the frosty weather, but good progress was now being made. A remit was made to ex-Provost Brownlee, convener of the Works Committee, and the electrical engineer to engage a staff. The boilers have been built in, the engines and motors are in position, and almost all the connections have been made. It is expected that the boilers, engines, and connections will be tested this week, after which the electric motors will be put in motion. Already 54 meters have been applied for. At a meeting of the Property Committee of the Dundee Town Council offers were submitted for erecting wires in the Town House to light the Town Chambers, Burgh Court, and offices with electricity. These were opened, and the offer by Messrs. James Maxwell and Sons was accepted. The cost will be £140. The subject of lighting the central police office and the public clocks in the city, including the Old Steeple, with electricity came before a sub-committee of the Dundee Police Commission this week. The burgh engineer was instructed to prepare a specification and estimate of what it would cost to light the central police office, and also to take in tenders for the work of wiring. As regards the Old Steeple clock instructions were given to advertise for tenders for lighting the dials with electricity.

Taunton.—Alderman James Standfast thus writes to the local papers with reference to the cost of the proposed Taunton installation: "Sir,—At our last Town Council meeting, I stated that in the £16,000 estimate for electric light nothing was entered for loss on issue of stock. The Mayor said it was reckoned in the £14,000, which would be more than enough to cover the loss on the extra £2,000, our stock having considerably increased in value. By submitting a copy of the £14,000 estimate also the extra £2,000 confirms my statement that nothing was entered for loss on issue.

Purchase of works	£9,300
Substitution of underground for overhead wires by the Fowler-Waring system	1,290
Extra wires in Corporation and Hammet-street	80
Taking up and laying pavement in present area	155
Extension of lighting (including taking up and laying pavement)	432
Wiring from mains to houses and transformers	300
Alteration of arc lamps	50
Extra wires for crossing roads	15
Alterations at depôt	506
Legal expenses	350
Working capital	1,000
Meters	300
Sundries	222
	£14,000
Extras—additional alternator	400
Extra boiler and fitting	450
Carrying out transverse steam-drum system	350
Belts and foundations	49
20 additional meters	200
Additional legal expenses	150
Sundries	401
Total	£16,000

Light or Energy at Bath.—Mr. Sturges, in presenting bills to the Bath Surveying Committee, said the surveyor (Mr. Fortune) had declined to endorse the account from the Electric Light Company, amounting to £543, with reductions amounting to *£1. 2s. 10d.* for the time lamps were not burning, at the usual rate of 1½d. per hour per lamp. Mr. Fortune thought this reduction altogether too insignificant to act as a deterrent to neglect, and suggested that the full Board of Trade fine of £2 per lamp per day for any neglect to supply light, however short the duration of non-supply, should be imposed. Mr. Sturges, after consultation with Mr. Massingham, the manager of the light works, said Mr. Fortune was wrong in suggesting that the authority had the power to inflict this penalty. The license stated that when the undertaker made a default in supplying "energy" for the public lamps he should be liable to certain penalties. It did not say light. Energy and light were two different things. General Mainwaring said the whole power of light by electricity was energy. Mr. Sturges: It doesn't follow because you have energy you have light. The Clerk said the license defined "energy to the public lamps," and, in his opinion, there was good ground for the surveyor's suggestion. The question was referred to the Lighting Committee, but it was agreed that the company should be paid £450 of the bill. A complaint as to the early hour at which the electric light is extinguished was referred to the same committee.

Newcastle.—Mr. George Lamb, lamp inspector, has presented the following report to the Lighting Committee of the Newcastle Corporation. "Gentlemen,—In accordance with the instructions of the committee, I visited London in December last for the purpose of obtaining information relative to the lighting of streets by means of electricity. I found that in the metropolis, as in other towns, the lighting of public streets by electricity is still comparatively in its infancy, and although it is further advanced than in most towns in England, still it cannot be claimed that an ideal state of street-lighting has been reached. The City of London Electric Lighting Company have contracted to supply 517 arc lamps of 10 amperes giving an illuminated power of 1,000 candles (actual), at an annual cost of £26 per lamp, which includes post, lamp, erecting, and maintenance. They have also contracted to supply 906 incandescent lamps of 100 and 200 watts at the option of the Commissioners, the price being for 100-watt lamps, £5 per lamp per annum, and for 200-watt lamps, £10 per annum; the illuminating power being 32 and 64 candles respectively. The lighting by the latter class of lamps is only in the experimental stage, and it is not yet settled which of the two lamps will be adopted to light the lesser thoroughfares. To enable the committee to make a comparison I may state that the gas-lamps in Newcastle which nearest approach to the 100-watt incandescent lights are those in Grey-street, which burn 10ft. of gas per hour and giving a light equal to 30 candles—taking 15 candles as a standard. The cost of these gas-lamps is £5. 8s. (less 5 per cent. per discount) per annum each. The average life of the incandescent lamp is about 1,000 hours, and by that time the illuminating power has considerably diminished, sometimes as much as 50 per cent., and this is one of the greatest drawbacks to this simple form of electric lamp for street-lighting. The arc lamps are placed at 43 to 50 yards apart, and the height from the ground to the centre of the arc is 18ft. 6in., as against 27ft. in Newcastle. The incandescent lamps are fixed upon the ordinary lamp pillars. All the lamp pillars in the City are placed upon the footpaths just within the kerbstone, excepting when a street is intersected by another street, and in these latter cases the lamps are erected in the centre of the roadway. The arc lamps in use are the Thomson-Houston and the Brush double-carbon lamps, and they are placed in hexagon-shaped lanterns, glazed with rippled plate glass, which has the effect of breaking up the rays of light, and so prevents the blinding effect which the lamps would have at the height of 18ft. 6in. from the ground. This is only accomplished, however, at a loss of certainly not less than 20 per cent. of the illuminating power. The system of lighting being continuous-current, the whole of the rays of light are thrown in a downward direction, and so effectual is this that the top portions of the lanterns are quite black when the lamps are lighted, and consequently reflectors are discarded entirely. The arc lamps are run in series of 50, and in no case can two lamps nearly opposite each other on different sides of a street be out at the same time, thus avoiding the danger of having a whole street left in total darkness. In the event of any lamp being out, the contractors are liable to a penalty of 1d. per minute per lamp, with a maximum penalty of 5s. per lamp per night, or day when required in the daytime, besides having to pay all the cost of lighting by other means if the electric lighting should fail. A very simple form of removable step is used in getting up to trim and clean the lamps; holes are made in the upper portion of the pillar, into which iron steps can be inserted by the person attending the lamps, and only a short ladder is required to reach up to where the first step is inserted in the post. The step holes are so small that they do not disfigure the post, and everything is so simple that one man can trim and clean from 40 to 50 lamps per day. Two men are on duty all night, and they are always in touch with the police, ready to proceed to any lamp which may be out or defective. They are each provided with a tricycle, on which everything is carried to enable them, under ordinary circumstances, to put a lamp right, and a bonus is given to each man according to the result of the working of his district. The St. Pancras Vestry is the only vestry in London which has taken into their own hands the power to supply electricity for public and private lighting. The first annual statement of accounts has just been published, which shows that the work undertaken by the Vestry has in every way been successful. The arc lighting in the streets is done entirely by the Brockie-Pell double-carbon 10-ampere lamps, with an illuminating power of 1,000 candles, placed upon pillars ranging from 22ft. to 25ft. high, the greater part of which are placed in the centre of the roadway. It is found, however, that the 25ft. post is too high, and I understand that the whole of the 25ft. posts will, in course of time, be replaced by posts of a lesser height. The lamps are placed at distances apart varying from 46 to 70 yards, opalescent globes being used to avoid shadows. To enable the men to trim and clean the lamps, a round platform is permanently fixed at the top of each post, and a light extension ladder is carried by the trimmer, who, assisted by a boy, attends to the whole of the 90 lamps now in use. The annual cost of the arc lamps is £12 each, and this covers the working expenses and interest upon capital sunk for street-lighting. The lighting of the streets being carried on in conjunction with private lighting, the working expenses are cheaper than they would be if worked alone. The charge is very low, and the work done by the St. Pancras Vestry is a good example of what can be done under such conditions. The points which, in my opinion, stand out most prominently are the following : (1) If street-lighting is to be carried out successfully it must be by the continuous-current system. The alternating current is adopted by both companies in Newcastle. (2) If the electric lighting is to be done cheaply, as large a portion of the city as possible should be covered, and not in the isolated manner it is now carried out in Newcastle. (3) Seeing that the charge for arc lighting is somewhere between £12 (the lowest) and £42 (the highest) per lamp per annum, the committee should ascertain what is the cost of lighting the chief streets in the central portion of the city by means of gas and at what cost either of the electric lighting companies would light the same streets. (4) The electric lampposts in Newcastle are too high for ordinary street-lighting. This was pointed out to the committee at the November meeting. I believe for all practical purposes posts about 19ft. high are more suitable for street-lighting than the existing posts. (5) The arc lamps upon the market at the present time which give the best results are the Brockie and Pell (the lamp now in use in Newcastle) and Brush. The Brush Company are prepared to lend a lamp to either of the electric lighting companies in Newcastle in order that the committee may have the opportunity of seeing it in actual operation in the streets. This offer I would respectfully ask the committee to accept."

Edinburgh. — The report of the deputation from the Town Council of Edinburgh to see various systems of electric lighting in use has now been issued. At present, say the reporters, a great many corporations seem to be making enquiries into the matter of electric lighting, judging from the number of deputations which had preceded us at different stations. We feel sure that the delay of the Corporation in taking up the work has been of great advantage to the city, on account of the experience gained by other towns, as well as improvements which have been introduced We have to acknowledge very kind receptions from corporations, companies, officials, and others in the various stations we visited. Obviously, it was only from representatives of corporations that we could expect full details bearing on the financial success of electric lighting ; and for much valuable information we have to thank Mr. Gibb, the vestry clerk of St. Pancras ; Alderman Finch, Alderman Whitmore, and the Town Clerk of Cambridge ; also the Mayor, Alderman Priestman, chairman of the Lighting Committee, and the Town Clerk of Bradford. From conversation with these authorities we learned that experience has shown that electric lighting is not likely to prove profitable until the second or third year, as many consumers only apply after they have seen the light used by more enterprising neighbours. In the various places visited we found that the demand for electricity was increasing, and that extensions of plant were contemplated or in progress. We were very strongly advised by those municipal authorities with whom we came in contact to work the electric lighting order ourselves, and not to hand it over to a company. Many of the reasons adduced were similar to those familiar to the citizens of Edinburgh in connection with the acquisition by the town of the gas and tramways, and the deputation could not discover that a company would be able to carry out electric lighting more economically than a corporation. Mr. Gibb and Prof. Robinson estimated that the Vestry of St. Pancras saved themselves a large sum by taking separate contracts instead of letting out the installation as a whole to one firm. At this stage the deputation are not prepared to give a preference to any of the systems visited by them. They are of opinion that the system most suitable for Edinburgh can only be selected after a careful consideration of the sites available for a central station or stations, and the area to be supplied therefrom. Where there is no objection to chimney stalks, and where the area is compact and not too large, like the low-tension districts in London and Bradford, a low-tension system, with the generating station planted right down on the network of supply, is considered best. Where the consumers are scattered over a wide area, or where a site for a chimney and engines cannot be obtained within the network of supply, high tension should be adopted, as the large size of copper mains required to convey any considerable quantity of current at low tension from a distance, without excessive loss, makes the price prohibitive. High-tension currents, whether continuous or alternating, should not be introduced within consumers' premises, but may be employed to produce low-pressure currents, which are quite free from danger. The conversion of high-pressure electricity into low-pressure may be effected either at consumers' premises, or at a sub-station from which low-pressure current could be supplied to a number of consumers. High tension has until lately been only employed on the alternating-current system in conjunction with transformers on consumers' premises, these transformers feeding a low-tension alternating current into the house. To this arrangement there are some objections : (1) Of risk, which experience has proved to be trifling ; (2) electrical and magnetic losses, which are more serious drawbacks. Lately, in some instances, this system has been modified, where many consumers were situated near each other, and alternating-current transformers have been banked or grouped at sub-stations, whence the current has been fed into a low-tension network similar to that employed on pure low-tension systems, it being always understood that the low-tension current supplied to consumers is alternating instead of continuous. The deputation regret that there is not more experience of this latter method of supply, which is well spoken of by the companies who have tried it, the general opinion among them being that where the demand is sufficient in any small area, transformers will in future be banked. Until recently, high-tension continuous current has not been employed in ordinary town installations, and the deputation were, therefore, the more interested in inspecting the Oxford station, where this system has been running successfully for some months. The high-tension continuous current cannot be transformed by means of ordinary transformers, but motor-dynamos are used instead. As these must be constructed with moving parts, requiring attention at intervals, they are not well suited for private houses, but may be placed in sub-stations to supply a low-tension continuous-current network. Continuous current, in the view of the deputation, is more applicable to motors, electroplating, etc., than alternating current. Motors, however, do not appear to be much employed. It also possesses the advantage of being available in conjunction with storage cells, the use of which may greatly facilitate the supply at certain times. As an example, the generating plant at the central station might be employed during the day to charge storage cells placed in a sub-station in a residential district, which could then run from its own resources during the hours of greatest demand, when the generating plant is fully employed serving shops, theatres, etc. This has the double advantage of reducing the size, and therefore the cost, of the generating station, and of employing the plant there for a greater number of hours per diem. Central-station engineers agree that the high cost of electric light is in a great measure due to the fact that their plant is only working at a profitable load for a few hours per day. On the other hand, the first cost of accumulators is very considerable, and the average life of a cell is estimated at about 10 years. The deputation also consider that with continuous current there is less need of precaution against accident than with alternating. At Oxford, while standing on dry flooring, the Lord Provost and Mr. Murray, following the example of Mr. M'Lean, the engineer, placed their hands on the high-pressure terminal of a sub-station motor-dynamo under a pressure of 1,000 volts, this being in marked contrast to the caution necessary on visiting high-pressure alternating-current stations. The deputation feel that the high price of motor-dynamo transformers, as compared with that of alternate-current transformers, is an objection to the high-tension continuous-current system, and it must be confessed that the alternating system has the advantage of allowing a separate transformer to be used on the premises of an ordinary consnmer who may be outside of the low-pressure network supplied by sub-stations of banked transformers. A large part of the report is taken up with details of the plant and working of the various stations visited. The Newcastle and District Electric Company (Parsons) have a plant with a capacity of 16,000 16-c.p. lamps, and they work to a mean distance of three-quarters of a mile. The current leaves the station at 1,000 volts pressure, and is transformed at the consumers' premises to one of 100 volts. The company charged 6d. per unit, and pay a dividend of 5 per cent. Consumers who were visited by the deputation expressed themselves highly satisfied with the supply. The extra cost over gas, which in Newcastle is 1s. 10d. less 10 per cent., is compensated by the cleanliness, purity, and coolness of the electric light. It was also reported at the gas office that though the receipts from users of electric light had decreased, there had been an increase in the gross consumption, partly owing to the use of gas for high candle-power burners to compete with the electric light. The Newcastle Electrie Supply Company (Brush) work to a distance of 4,024 yards. They send out the current at 2,000 volts, and transform to 50 or 100 volts on the consumers' premises. They charge 4½d. per unit. and pay 4 per cent. dividend. The St. Pancras Vestry, Regent Park Station, work on the three-wire low-tension continuous-current system, the consumers' lamps being at 110 volts pressure. A separate plant is installed for lighting nine parallel streets of 10 street arc lamps in each series. The area of supply is about a mile square, with 5½ miles of streets in which mains are laid. The consumers number 171. The Vestry charges 6d. per unit during lighting hours, and 3d. per unit during the day for motive-power purposes, and lighting basements and cellars. About 10 per cent. of the current is used for motive power. The total cost of the installations and extensions on hand was £92,000. The balance to credit up to the end of the first year was £1,068. A total annual income of at least £10,000 is expected, irrespective of about £3,000 worth of current used for public lighting. The vestry clerk estimated that each 16-c.p. lamp installed will yield an income of £1 per annum at 6d. per unit. There are 13,000 lamps installed, and the demand is increasing. The vestry clerk considers the system reliable and satisfactory, and the price remunerative. The House-to-House Electric Supply Company, West Brompton, use the high-tension alternating system with transformers on consumers' premises. The total capacity of the plant is 23,000 10-c.p. lamps. The dynamos can be run in parallel or separate circuits. The current leaves the station at 2,000 volts pressure, and is transformed to 100 or 50 volts as required. The area of supply is about four-fifths of a mile, and the number of consumers about 500, about 80 per cent. representing private houses. The company charges 8d. per unit, and pays a dividend of 4 per cent. on preference shares. The Westminster Electric Supply Corporation use the three-wire low-tension continuous-current system with secondary batteries. The pressure leaving the station is 200 volts, and at the consumers' 100 volts. The area of supply is 1·9 mile. There are 97,800 8-c.p. lamps connected with the mains. The price charged is 7d. per Board of Trade unit—6½d. for large customers. The capital of the company is £300,000, and the shares are quoted above par. The City of London Electric Lighting Company work the alternate-current high-tension system, with transformers at sub-stations feeding a low-pressure three-wire network, the consumers' lamps being 100 volts. The company charge 8d. per unit, and are unable to meet their present demand. They are at present extending their works on a large scale. The St. James and Pall Mall Electric Lighting Company work on the low-tension, continuous-current three-wire system, with 100-volt lamps. The area of supply is 2¾ square miles. There are 500 consumers. The company charges 7d. per unit, and pays a handsome dividend. The Cambridge Electric Supply Company employ the high-tension alternating-current system, with transformers on consumers' premises. There are four main circuits. The current is transformed from 2,000 volts pressure to 100 volts. The distance of the furthest lamp is two miles. The company charge 7d. per Board of Trade unit. It has only been in operation a few months. The Bradford Corporation employ the low-tension continuous current with secondary batteries, and with pressure at consumers' lamps of 112 volts. The consumers at present are mostly shopkeepers, some of whom the deputation visited, and found well pleased with the supply. The price is 5d. per Board of Trade unit. For the first two years the station was worked at a loss, but since that time the net revenue has been increasing by about £300 per half-year. The interest paid on the sinking fund is sufficient to clear it off in 30 years. The Oxford Electric Company, Limited, use the high-tension continuous-current system, with motor-dynamo transformers distributing at low-tension continuous with secondary batteries, the pressure at consumers' lamps being 100 volts. The price charged is 8d. per Board of Trade unit. There are 14 seven-ampere arc lamps fitted up for street-lighting. The town authorities pay the company £27 per lamp per annum on a three years' contract. The relative cost of street-lighting is : Gas, £172 ; electricity, £385. This increase of cost is said to be compensated by the greater efficiency of the electric light.

PROVISIONAL PATENTS, 1893.

JANUARY 16.

933. **Improvements in electrical arc lamps.** William H. Lauder, 33, Blessington-street, Dublin.

JANUARY 17.

1005. **An improved method of electrically controlling railway signal and point levers.** Charles Marmaduke Anderson, 7, Wellington-street, Higher Broughton, Manchester.

1035. **Improvements in electrical indicating apparatus, chiefly designed for indicating the position of a ship's rudder.** Marie Louise Bossière, widow of Henri Bossière, and Piérre Phillippe Barbry, 4, South-street, Finsbury, London.

1037. **Improvements in searchlight projectors and in other light-giving and projecting apparatus and more efficient distribution of the light produced, and in mellowing of the light rays.** James Weir Graydon, 50, St. James's-residences, Little Pulteney-street, London.

1057. **Improvements in and relating to electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Harris, United States.)

1077. **Improvements in electric telephone switch apparatus.** William Phillips Thompson, 6, Lord-street, Liverpool. (Carl Christian Ernst Lesenberg, Germany.) (Complete specification.)

JANUARY 18.

1098. **Railway junction electric signalling.** William Edward Langdon, Electrical Department, Midland Railway, Derby.

1104. **The signalman's electric safety protecting stop-catch.** Alfred Fenney and Charles Eccles, 29, Rawlinson-street, Barrow-in-Furness.

1112. **Improvements in charging primary batteries for electric lighting and other purposes.** Samuel Miller and Charles James Grist, 1, Langton-cottages, Melbourne-square, Brixton, London.

JANUARY 19.

1166. **Improvements in electric switching devices.** Henry Raymond Wood, 11, Grocer's Hall-court, Cheapside, London.

1168. **Improvements in the production of sodium carbonate and sodium bicarbonate from metallic sodium or metallic sodium vapour, the said sodium or sodium vapour being obtained electrolytically or by other methods.** James Bury Petrie, Castleton Cottage, Castleton, near Manchester.

1198. **Improvements in multiple-carbon arc electric lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

1219. **Improvements in single-phase alternate-current motors.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

1229. **Improvements in secondary or storage batteries.** Henry Herbert Lloyd, 323, High Holborn, London. (Complete specification.)

JANUARY 20.

1261. **Improvements in dynamo-electric machines.** Eugene Conrady and Edmund Conrady, 56, Low-street, Keighley.

JANUARY 21.

1309. **Improvements in or relating to dynamo-electric machines.** Henry Courteen, Bromleigh, Severn-road, Weston-super-Mare.

1336. **An automatic switch for obtaining continuous electrical current from a series of open-circuit batteries.** Edward Blamire, 27, Kirkgate, Bradford.

1354. **Electro-thermal conductors, plates, tubes, and the like.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

1355. **Improved apparatus for forming elec tro-thermal plates, tubes, conductors, and the like.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

1356. **Improvements in electric gas-lighting appliances and devices.** Aaron Moses Sloss, 1, Quality-court, Chancery-lane, London. (Complete specification.)

1382. **Improvements in phonoporic inductors.** Walter Langdon-Davies and Charles William Scott Crawley, 24, Southampton-buildings, Chancery-lane, London.

1387. **Apparatus to facilitate the placing of electric or other cables or wires within and the removal from pipes or conduits.** Edward Thomas Mercer and Malcolm George Ross, 46, Lincolns-inn-fields, London.

1391. **Improvements in electric arc lamps.** Karl Schleyder, 323, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1879.

412. **Compound microphones.** Crossley. (Fourth edition.)

1889.

11084. **Electric fuses for torpedos, etc.** Kelway. (Second edition.)

17425. **Electric arc lamps.** Harper. (Second edition.)

19153. **Phonographs.** Hardingham. (Edison.) (Second edition.)

1890.

3096. **Electric meters.** De Ferranti. (Second edition.)

1891.

22640. **Electric arc lamps.** Sayers.

22686. **Electric forges.** Angell.

22687. **Heating metal by electricity.** Angell.

1892.

1656. **Electric brakes.** Johnson. (De Bovet.)

2162. **Automatic arc lamps.** Crompton and Pochin.

2365. **Electrical communicating apparatus.** Mabon.

2981. **Electro-medical appliances.** Craven.

3120. **Galvano plastics or electro-deposition of metals.** Bertrand.

3366. **Dynamo-electric machines.** Hemming.

3801. **Electric bells.** L. W. and W. H. Winnall.

3919. **Repairing incandescent electric lamps.** Rawson and Woodhouse and Rawson United, Limited.

12506. **Telephone transmitter.** Jones.

14813. **Electric battery plates.** Usher.

14815. **Storage batteries.** Usher.

17751. **Door lock switch for electric lights.** Redfern. (Green.)

20606. **Electric arc lamps.** Day. (Higham Electric Company.)

20611. **Governing electric motors.** Mills. (Lundell.)

20864. **Telephone receivers.** Pollitz.

20894. **Telegraphic, etc., call systems.** Wetzer.

21268. **Suspending electric incandescent lamps.** Porter and White.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5	5½
	3	3¾
London Electric Supply	5	¾
Metropolitan Electric Supply	—	7
National Telephone	5	4¾
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	6

NOTES.

Electric Club.—The New York Electrical Club has been dissolved owing to financial difficulties.

Electrical Railways.—Dr. Edward Hopkinson will lecture on Friday, February 24, before the Royal Institution, on "Electrical Railways."

Nice.—The theatre at Nice is lighted by 34 arc lamps, with incandescents in the coffee-rooms and salons, which are also ventilated by means of electric motors.

Central-Station Accumulators.—A long article on the calculations for the accumulators necessary in a central station is given in *L'Electricien* by M. A. Palaz.

Domestic Electricity.—Mr. William Smith delivered a lecture on Tuesday before the Aberdeen Mechanical Society on "The Domestic Uses of Electricity."

House-Lighting. — We have received a copy of Mr. Fahie's "House-Lighting by Electricity," recently noticed, now issued in a bound form from Messrs. Spon and Co.

Indian Journalism. — The *Indian Engineer* has blossomed out for the new year into a paper half as large again. It is giving a great deal of attention to electrical matters.

Lecture.—A lecture on electricity and *conversazione* of the electrical engineering class will be held at the Whitgift Grammar School on Wednesday, the 8th inst., the lecturer being Mr. W. Perren Maycock.

Howard Lectures.—The fourth of Prof. Unwin's extremely interesting and important lectures on distribution of power will be given to-night (Friday) before the Society of Arts, the subject being water-motors.

Royal Institution.—Mr. Alex. Siemens will lecture to-night, at 9 o'clock, on "Theory and Practice in Electrical Science," with experimental illustrations. On February 18 Lord Rayleigh will begin a course of six lectures on "Sound and Vibrations."

Separate Motor Circuits.—For the past two years separate motor circuits have been run in many American towns by the Edison companies at 220 or 500 volts. Boston has both pressures, though the preference is for the lower voltage. At Providence there is between 500 h.p. and 600 h.p. distributed on a 500-volt circuit.

Inattackable Anodes.—M. Henneton applies to anodes destined for use in electrolytic dissociation processes a frame entirely or in part metallic, on which are fixed wires, a web, or plate of metal, inattackable in the electrolyte for which the anode is required, this frame being insulated by covering with an insulated body applied by compression.

De Magnete.—The New York *Electrical Engineer* contains a review last week of Mr. P. F. Mottelay's translation of Gilbert's "De Magnete," advance sheets of which have been sent them. The book is issued by Wiley and Sons at 4dol., and has created a good deal of discussion as intervening before the promised production of the work by the Gilbert Club in England.

Bleaching Starch. — We hear reports that the purification of the second and lower qualities of starch by electrolytic bleaching has been so successful that the purified starch is sold for even a higher price than the first quality, and the enterprising manufacturer who adopted the process has paid for the electric apparatus three times over within one year by the gains effected.

Electric Pianos are now to be had, which play by themselves when the electric current is turned on. They have the appearance of ordinary cottage pianos, but at the back there is an opening for inserting the brown paper perforated rolls of music. One was shown by Dr. Thompson last week at his lecture before the London Institution, to the bewilderment and amazement of the spectators.

Watergate.—A device that should be useful in hydraulic motor work is an automatic watergate recently invented, worked by the weight of a hollow lever. When the water rises above a certain level it flows into this hollow lever and opens the gate, so keeping the pressure on wheels or turbines steady. The gate closes when the water falls, as the hollow lever has a small outlet by which it empties slowly.

Three-Phase Current Station.—A central station is to be constructed, it is stated, in the town of Pergine, Austria, in which the three-phase current is to be used. A 100-h.p. turbine, at 600 revolutions, will drive the dynamo at 1,000 volts, supplying current to the town 1¼ miles away. The current will be received in four transformers of different capacities, and reduced to 100 volts. The whole plant is supplied by the Oerlikon Works.

Parliament.—The Houses of Parliament opened their session this week, and, according to the *Daily News*, the effect of the electric light in the House of Lords was somewhat dazzling. The amount of candle-power to be used was arranged before the House was cleaned. The cleaning has been so effective as to considerably lighten the surrounding colours, and it will now be necessary, for the fuller comfort of members, to modify the light.

High-Potential Voltmeter.—The static voltmeter, with globes and rings, designed by Dr. A. Heydweiller, which we recently noted, is described in full, with illustration and plentiful tests, in the *Elecktrotechnische Zeitschrift* for January 20. The principle of repulsion of similarly-charged bodies is very prettily utilised in this instrument, which seems as if it might be destined to take its place alongside the well-known dynamometer of Siemens and Halske as a workshop instrument of extreme accuracy.

Cairo.—Visitors to the old Cairo streets in the Paris Exposition were greatly struck with the curious contrast of the old-world shops, coloured fabrics, and dusky beauties with the new-fangled brilliance of the electric light. What was there shown in imitation is now to be carried out in reality, for we hear that the gas company of Cairo have submitted a scheme by which they undertake to introduce electricity. This offer has been accepted, and M. Lebron, the director of this company, is now busy making definite arrangements.

Institution.—At the meeting of the Institution of Electrical Engineers last week, at the conclusion of Mr. Preece's presidential address, a vote of thanks was moved by Mr. Spagnoletti to the President for his admirable and interesting address, seconded by Sir Henry Mance, and carried by acclamation. The next meeting of the Institution will be held on the 9th inst., when Prof. Fleming will reply to the discussion on his paper on testing transformers, and a short paper will be read by Mr. W. M. Mordey on "The Testing of Alternators."

Book Received.—We have received a copy of the American authorised edition of "Original Papers on Dynamo Machinery and Allied Subjects," by John Hopkinson, M.A., D.Sc., F.R.S.: New York, W. J. Johnston Company; and London, Whittaker and Co. It contains reprints of all Dr. Hopkinson's papers of an original character on electro-technical subjects, from the Mechanical, Civil and Electrical Engineers, and the Royal Society's *Proceedings*, the *Philosophical Magazine*, and a report to the Westinghouse Company on two 6,500-watt transformers.

The Queen and the Electric Light.—Her Majesty, says a society note, is not a great admirer of the electric light. Last year, yielding to the persistent entreaties of the Princess Beatrice, she consented to have the royal yacht fitted up with the electric light. Only one stipulation was insisted upon, and that was that the light should not invade the saloon or her private cabin. The same influence, under the same restrictions, has at length triumphed at Osborne. The Indian Room is this month, for the first time, lighted with electricity, the electric light also flashing in the principal corridors. But the Queen will have none of it in her own apartments, or in the larger common rooms she frequents.

Filaments.—The new method of making electric lamp filaments adopted by the Société Anonyme des Lampes à Incandescence, of Budapest, consists, briefly, in taking silk, cotton, or other similar material and impregnating with the following mixture: Silicate of potass, 25 to 30 per cent.; Senegal gum, 10 to 15 per cent.; caustic soda, 12 to 13 per cent. The filament is compressed in the form of a sharp prism, the edges being found to radiate more than the facets. It is then carbonised and flashed; but instead of employing a carbide liquid or gas, the Budapest Company use a solid carbide, such as naphthaline or paraffin wax, which liquefies only in the vicinity of the filament, and assures a very regular layer of carbon. The filaments are prepared of any desired resistance before their introduction into the bulb.

Interference of Electric Waves.— M. Colson, before the Société de Physique, has shown an apparatus, using a telephone, demonstrating the existence of an interference or stationary node in a closed circuit; it is simple, precise, and sensitive. M. Colson points out that all apparatus working by a variation of potential of the point of contact is capable of showing this interference. He has verified it particularly with a Geissler tube held in the hand, and put into contact with the conductor by platinum wires; he checked the neutral zones found by the telephone. The Geissler tube lights up whether the frequency be high or not, while the telephone only acts below a certain frequency, but it is far more sensitive, and M. Colson thinks its use likely to lead to interesting results in determining the phenomena of electric waves.

Lantern Slides.—Lectures on electrical subjects being largely illustrated by lantern slides, the method employed by Prof. W. J. Waggener of actually printing the slides will be useful, though it is not altogether new. The slides prepared on this method are printed with the ordinary printing press and blocks on transparent gelatine sheets—singly or in sets, afterwards cut up. "By this means excellent lantern slides and engravings of nearly, if not quite, all kinds can be made and multiplied as rapidly and almost as cheaply as paper prints." It may be added that unsensitised transparent collodion makes an excellent ground for artistic or other pencil drawings or diagrams, as the surface takes the most delicate shading or lines with perfect clearness, and being at the same time very easy to work. Fine ground glass is also used by some lecturers.

Cantor Lectures. — The second lecture by Prof. Fleming on "The Practical Measurement of Alternating Electrical Currents," will be given before the Society of Arts next Monday at 8 p.m. Lecture II. will have for subject "The Measurement of Alternating-Current Potential," dealing with: Definitions of inductance and impedance; laws of current flow in inductive circuits; construction of non-inductive resistances; electrostatic and electrodynamic voltmeters; voltmeters of Kelvin, Ayrton, Swinburne, Cardew, Siemens, Elihu Thomson, Evershed, Nalder, and others; alternate-current potentiometers; employment of electrostatic voltmeters and non-inductive resistances for current measurements; standardisation of high-tension voltmeters; measurement of capacity of condensers and concentric cables; capacity effect in cables and condensers.

Purification of Sewage.—Mr. H. Leonard Hinnell, of Bolton, on Saturday afternoon addressed the Sanitary Inspectors' Association, Manchester, on "Sewage Purification." Mr. J. Maguire, chairman of the branch, presided. The lecturer pointed out that there were three processes of treatment of sewage in precipitation-tanks—the lime process, International process, and the purification of sewage by the electricity process. The last process had been put into operation at the Salford sewage works, and most satisfactory results had been obtained, but the cost of the process as yet prevented its general adoption. He believed, however, when worked in conjunction with a refuse destructor, the heat from which could be utilised to supply power for generating electricity from dynamos, it would be found eventually more economical and efficient than the majority of purification processes.

The Junior Engineering Society.—The eighth anniversary dinner of this society was held last Saturday evening at the Holborn Restaurant, the president, Dr. John Hopkinson, in the chair. A large number of the members attended. After the loyal toasts had been observed, Mr. W. J. Tennant proposed "The President," by whom it was acknowledged. "Science and Technology," proposed by Mr. David Joy in the absence through illness of Prof. V. B. Lewes, was responded to by Sir G. G. Stokes and Prof. John Perry. Mr. R. W. Newman proposed "The Vice-Presidents," which was acknowledged by Mr. W. H. White, of the Admiralty. The toast of the evening, "The Junior Engineering Society," was proposed by Sir F. A. Abel, Mr. Sidney Boulding, the chairman of the society, replying to it; and to the concluding toast, "The Visitors," proposed by Mr. H. B. Vorley, Mr. W. W. Beaumont responded.

Edison's Patent Forestalled.—A genuine surprise awaited the General Electric Company when bringing their injunction against the Beacon Company, of Boston, a few days ago. Affidavits and specimens of an incandescent carbon filament lamp made by an artisan named Goebel in 1859, were brought forward seemingly perfectly genuine; and this back-handed blow has stirred the electrical world of the States to its roots. The injunction was not granted. Goebel's lamps were made with a mercury vacuum, the filaments (held in a meat-saw shaped frame) were of bamboo, $1\frac{1}{16}$in. long by eight-thousandths diameter, carbonised and sealed with Dixon's stove-polish; even platinum (amongst other wires) was used. All this is sworn to by 30 persons as happening before 1860, and there seems to be good reason to believe it may be all true. If so, it will be one of the most extraordinary stories in science, and Edison's patent will be doomed.

Country House Transmission.—Earl Russell and Mr. B. W. Thwaite, in a three-page article in the *National Review* for February, propose that owners of country houses should combine and have their electricity generated and distributed from a central station. At some fixed place, preferably the railway station, an electric station under skilled management should distribute the power at high pressure. The station might also act as a telephonic exchange. For an ordinary householder the cost would be too great, but the high-pressure central-station system might reduce the cost sufficiently. A steam or fuel-gas engine would drive two alternators at low pressure; the current would be transformed up to suitable pressure accord ing to distance. Each householder would be supplied with transformer and meter in the same way as in towns, and a small joint-stock company might be made to run the station with limitations as to maximum prices.

Telegraphic Facilities.—Mr. W. P. Forbes, of the Central News, lectured to a crowded audience in the Lecture Hall, Wanstead, last week, on the collection and distribution of news. A special wire, extended to the building by the courtesy of the Post Office, was connected with the cable system of the Direct United States Cable Company, and over this a message was sent during the evening to President-Elect Cleveland at Lakewood, New Jersey, congratulating him, in the name of the meeting, upon his election to the presidency. Within 20 minutes the following reply was received through the United Press, New York, and read to the audience amid enthusiastic cheers: "Lakewood, New Jersey. Your message is received, and I trust that this expression, and my appreciation of the sentiments it contains, will serve to illustrate the stupendous growth of facilities for inter-communication throughout the civilised world.—Grover Cleveland."

Geometry Models.—The statement that the human mind cannot understand reasoning until the concrete representation of the facts reasoned on are thoroughly grasped, is becoming recognised in pedagogic practice. We are glad to notice the "Descriptive Geometry Models" devised by Mr. Thomas Jones, M.I.M.E., of the Central Board School, Manchester (and sold by the author at 27, Barton-street, Moss-side, Manchester, price 1s. 3d. net.), for these models certainly tend to the desired end. They comprise a variety of cardboard models with the geometrical lines printed thereon, with certain parts folded and cut for turning up, to give the visual demonstration of the problem. For instance, "a line shown by its traces," No. 2, has the part of the card marked "vertical plane" arranged to be turned up; the plan and elevation of an inclined line is actually shown by means of a black thread, and a number of problems can be deduced or demonstrated from the single card. There are six models in the box containing the first set, ranging up to problems of the angles between two planes. This admirable method of actual demonstration to students might still further, however, be made of good use by applying the examples to the supposed measurement of real objects—fields, engines, or other, instead of remaining, as in the examples given, absolutely abstract—for the abstract is the bugbear of the beginner. Mr. Jones is evidently a teacher of real insight and inventive power: his working cardboard models of steam-engine slide-valves in a similar series would be extremely valuable in giving correct ideas to young students in mechanics.

Dynamo Faults.—A neat little book which will go into the blue serge pocket of the dynamo tender with ease and comfort, is "How to Manage a Dynamo," by the English mechanic's old friend, S. R. Bottone—"a handbook for ship engineers, electric light engineers, electroplaters" (Whittaker and Co., 1s.). There are several good points to recommend it. In the first place, there is a large frontispiece containing illustrations of the usual types of dynamos, large alternator, "Manchester," Edison-Hopkinson, Gramme, and Mordey machines. A sufficiently carefully written account of the parts of a dynamo are given — series, shunt, and compound. Then follows the more usefully practical part — on installing a dynamo and how to discover and obviate its faults. "See your commutator runs true and the dynamo does not vibrate" if you wish to have the pride of a dynamo-minder—a polished sparkless commutator. Mr. Bottone takes his readers through the usual defects of dynamos, and shows how to test for them, giving diagrams of the more simple tests. Cover your dynamo when idle with a white holland cloth, is Mr. Bottone's advice, and blow dust away with bellows. "For cleaning the dynamo, cotton or other waste is inadmissible owing to the liability of fibre being carried into armature; cloths alone should be used." For a practical handbook to be given by managers, engineers, shippers, or proprietors of installations to their men, this little book will be very useful. There is a good deal, naturally, about brushes; there is no need, however, to foster a common error by spelling the Brush machine with a small letter, otherwise the wording is careful and the diagrams helpful.

Electric Drop-Curtain.—At the Comédie-Française, the French National Theatre in Paris, a new drop-curtain, raised and lowered by electricity, has been installed by the Edison Company, with the help of M. Anton, chief machinist to the theatre. The curtain, says a note in the *Times*, is suspended by five parallel ropes, which run over an equal number of pulleys fixed above the scene, and are then wound together on a wooden drum, capable of turning in one direction or the other in order to make the curtain ascend or descend. This movement is produced by means of a belt connecting the drum with an electric shunt motor and a counterweight attached to the drum by a cord. The conductors of the current, which is derived from the Palais Royal Station, come to a switch placed in reach of the machinist, who thus controls the motor and the curtain. The latter weighs 400 kilogrammes, and is entirely balanced by the counterpoise, so that the motor has only to overcome the friction of the apparatus, which amounts to about 2 h.p. The brushes of the motor are of carbon, a device originally introduced by Prof. George Forbes, which avoids the strong sparks caused by metal touching metal. There are three speeds of descent, and two of ascent. The maximum speed of descent is 1·50 metres a second, the mean is 1·10 metres a second, and the minimum 0·75 metre a second. In rising the speeds are 0·75 and 1·10 metres a second. The range of the curtain is 9·60 metres. A current of from 10 to 60 amperes is employed. A system of electric bells to direct the machinist in working the curtain is also provided. The innovation is giving every satisfaction, but a few of the *sociétaires* are said to regret the "majestic slowness" of the old drop-curtain.

Electrical Trades' Smoking Concert.—After a very pleasant football match was played on Saturday last at Charlton Park, between the employés of Messrs. Johnson and Phillips and Siemens Bros. and Co., Limited, the former gave a complimentary smoking concert at the King's Arms Hotel, Woolwich. The concert, which was organised by Mr. Mould, captain, and Mr. Sheppard, secretary, of Messrs. Johnson and Phillips's team, took place in the splendid concert-room of the King's Arms, and was filled with employés of the two local electrical engineering firms. Mr. Ernest Brandon was in the chair, and after the introductory overture by Mr. Dungey, Mr. Graham sang "Johnson's Ball" in good style, after which Mr. Osborne Morgan, the talented comedian, excellently rendered "The Story of a Kiss;" this necessitated an encore, "The Coster's Courtship," which was received with much gusto. Mr. Degan then delighted the audience with "Anchored" and "The Beacon; after which Mr. Sinclair played a pianoforte solo in his usual admirable manner. Mr. Davidge, a comedian of merit, then aroused the humour of the company with "Afterwards," and responded to an encore. Mr. Mould was well received with "They All Love Jack," as also was Mr. Deeks, whose rendering of "The Man who Broke the Bank at Monte Carlo" was so much appreciated that the meeting would only be satisfied with an encore. Mr. Darvell and Mr. G. Clarke also gave humorous songs. Mr. E. A. Brandon then proposed the health of Messrs. Siemens Bros. and the employés, and referred to the lamented death of Dr. Werner Siemens. Mr. Sinclair gave the toast of Messrs. Johnson and Phillips and employés, and the success of both firms was drunk with great enthusiasm. Mr. Dungey very efficiently officiated as accompanist, and a very pleasant and enjoyable evening closed with "Auld Lang Syne."

Transformation into Continuous Currents.—The transformation of alternate currents, either ordinary or polyphase, into continuous currents is now realised, says the *Bulletin Internationale*, and the importance of the discovery will escape no one. Alternate currents have had to struggle, in the first place, against prejudice, without speaking of the difficulties of working proper to themselves. But to-day, though these obstacles have disappeared, there are nevertheless cases in which the use of alternate currents presents an inconvenience. The alternate current does not lend itself to the distribution of power for household use, and cannot be used for electro-chemical purposes. The researches of electricians have therefore been directed towards the transformation of such currents into a continuous current, in such a manner as to preserve their special quality of ease of transmission to long distances by utilising water power, and at the same time to obtain the advantages of continuous current for facility of distribution, its equal aptitude for lighting, and the advantage of use of the current for motors and for electro-chemical operations. The inventors of a transformer of this nature are Messrs. Hutin and Leblanc, to whom we owe many researches on alternate currents. The apparatus is formed of two similar magnetic cores carrying two primary windings for two alternate currents displaced at quarter period. An ordinary commutator and a pair of brushes placed diametrically opposite each other complete the system. On each core are also a certain number of coils, the number of the turns is variable, being subject to a special law. These are connected to the contacts of the commutator according to a special arrangement better explained by a diagram. If the commutator is rotated by means of a small synchronous motor, a continuous current is collected from the brushes. In the machine constructed by the inventors a six-pole synchronous motor turns a commutator of 36 segments, this number being determined so as to reduce the speed to one-third. These contacts communicate three by three with 12 rings, each furnished with a rubbing contact, being in relation with the 12 elementary coils which produce the continuous current. The two brushes, capable of adjustment, are mounted on the circuit which utilised the continuous current. The apparatus is reversible, and if supplied with continuous current, gives off alternate currents, the frequency being dependent on the speed of brush rotation. The last quality will not prove very useful, whilst the first may completely revolutionise electrical industry.

The Electric Club of Victoria.—The recently established Electric Club of Victoria held its inaugural dinner on the 14th December. There was a large attendance, and the chair was occupied by the vice-president (Mr. George Smibert), the president (Prof. Kernot) being unavoidably absent. The office-bearers of the club are the following: President, Prof. Kernot; vice-presidents, Mr. G. Smibert and Mr. H. A. Slater; hon. treasurer, Mr. G. Selby; hon. secretary, Mr. L. H. S. Ellson. The members of the council are Messrs. Murray, Wilson, Jenvey, Musgrove, Alcock, and Stone. Representatives of the various electrical interests in Victoria were present in large numbers. The supply companies were represented by Messrs. Mountain and Stains, chairman of directors and secretary of the A. U. Alcock Electric Light and Power Company; the Post Office Department, by the deputy postmaster-general (Mr. G. Smibert) and Mr. H. Jenvey; the Electrical Department of the Victorian railways, by Mr. P. Thompson; and the private electrical firms were represented by Messrs. Slater, Newton, Flesch, Pascoe and Gosché, and others. Mr. Kingsbury, vice-president of the Electrical Club of New South Wales, was also present. "At the present moment," says the Australian *Engineering News*, "of course it is difficult to say into what the club will develop itself. As a purely social club, it will, we are inclined to believe, be of little practical value to its members; on the other hand, the number of scientific members of the club is so very limited that it cannot possibly develop itself into a scientific club for many years to come. However, it does not matter what the club is termed, if it has at heart the practical advancement of electrical engineering in all its branches. Electrical work in Melbourne has so far very little to boast about, and it would be well for all who undertake electrical work in Victoria if the Electric Club could bring about a reform in the prices now being paid for all kinds of electrical installation. Unless good work be done we cannot expect to progress, and unless good prices are obtained we cannot expect to obtain good work. Nothing has done more harm to electrical progress in Melbourne than the indifferent work to be found in that city. It is to be hoped that the formation of the Electrical Club in Victoria will elevate the standard of electrical work to such a point that no fault may be found with it by even the most exacting." We note the formation of the organisation with pleasure, and trust that the active work of a few prominent members will give it a good standing and useful position in the colony.

Reversibility of Three-Phase Motors.—Mr. Ernst Danielson, writing from Westeras, Sweden, to the *Electrical World*, says: "One of the most interesting electrical machines of to-day is certainly the three-phase motor with inductive winding. A feature of this motor, which I believe has not yet been pointed out, is that it can also be used as a generator exciting its own field. This experiment has just now successfully been carried out in the works of Allmaenna Svenska Elecktriska Aktiebolaget, in Westeras, Sweden (the General Swedish Electric Company). The experiment was arranged as follows: A three-phaser, A, of 50 volts (as measured from the neutral point to each of the brushes), and with a current capacity of about 60 amperes, sent current to a motor, B, with inductive winding of about the same capacity. The construction of the motor was substantially the same as that of Brown recently described. The motor, by means of a belt, ran a continuous-current dynamo, C, of 330 volts and 16 amperes. Then matters were reversed, so that dynamo C, fed from a 330-volt circuit, ran the motor, B, as a generator, sending a rotary current to the three-phaser, A, which then became a motor. The belt was then thrown off of A, and trials were made to brake it out of step with the current, but without success. The brake used was simply a lever made of wood and acting on the pulley. With these poor facilities, of course, no real measurement of the horse-power could be made, but, at all events, the torque was considerable. The explanation of the possibility of such a motor to act as a generator is this: From theory and experiment it is known that when two attractions — single-phasers or multiphasers—are working synchronously, one as a generator and the other as a motor, the phase of the current lags behind the E.M.F. of the motor, whereas it is in advance of that of the generator. The result of this is that the current weakens the motor field and strengthens that of the generator. The action of the inductive three-phase motor as a generator, then, is this: The armature current induces magnetic lines in the field, and these lines, by means of the closed-circuit winding, are prevented from changing their positions very rapidly in the iron, and, therefore, they must rotate with nearly the same speed as the rotation takes place. Now, this field is capable of maintaining the current, provided the conditions in the external circuit are such that the current comes in advance of the induced E.M.F. These conditions can be fulfilled by having a regular three-phase generator in circuit, or by condensers. It would be impossible to have the motor act as a generator on a regular lamp circuit, or a circuit with self-induction. Experiments also showed this: Resistance-boxes were connected between the leads joining the three-phaser and the motor. When the motor, B, ran as a generator it accordingly sent current not only to the three-phaser, A, but also to the three resistance-boxes. When the three-phaser was switched off, the motor, B, immediately stopped generating."

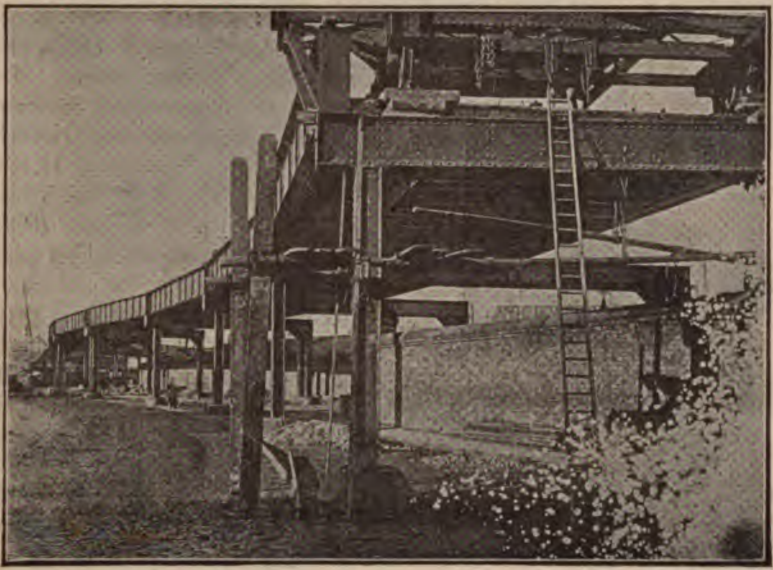
"My Lords and Gentlemen."—The great characteristic of the English gentleman is restraint—some would even say coldness. The "stony British stare" is not to be got over by a garrulousness without mercy and a pretension without pains. So, indeed, the high-class electrical engineer argues, and constructs his introductory prospectus accordingly. At least one of them follows this tack, and on the front page of Messrs. Edmundsons' "Electric Lighting" list, we are at once taken on that familiar ground to Lords and Commons—the view of the Houses of Parliament at Westminster, which also includes in the foreground the premises of the said high-class restrictive firm. We start well; and save for the warnings of Mr. Musgrave Heaphy on the selection of honest engineers, printed in full on the inside cover, no word is said by anyone not in the "Court Guide." We feel ourselves in a select and aristocratic region. One moves but in the company of the great. The names of the duke, the duchess, and the marquis or earl of this or that, follow each other in a stately procession before us. After "my lords" come the gentlemen, and then still more lords—owners of yachts. No one speaks, save one's own peers (as the usual recipient of this missive will remark). "Revelstoke" considers the electric light "admirable," and in stately words praises its success. "Muncaster" confesses that the electric light involves the Carlton-gardens *ménage* in "no greater expense than gas"—no doubt with surprise and pleasure—"whilst its light is infinitely superior." The Right Hon. Lord Iveagh seems a constant customer. Farmleigh, county Dublin, starts the ball rolling, then we jump to Grosvenor-place, London, also electrically illuminated (no doubt in the highest style). Next we go to that noted place, St. Stephen's Green, Dublin—to the patriotic town house of the Irish peer. Nor is his English country mansion (at Benacre Hall, Beccles) without its electricity. Even this is not all. An electricity-loving peer is Lord Iveagh, and his two yachts, "Ceto" and "Cetonia," are furnished in the same delightful manner withal. Who could fancy a mere list of testimonials to a company of electrical engineers could furnish such glimpses of grandeur and whiffs of wide water and romance? Who would not be a lord, or at least a captain or gentleman of estate, to order "electric light throughout," and then send testimonials, even if written in bald prose, to say that "everything is most satisfactory. We never have the smallest hitch, and nothing can work better than every part of the lights and machinery does"? The pleasure of taking visitors down into the dynamo-room and pointing out "my installation" is some part of the satisfaction to be derived from the introduction of the new illuminant, as well as that of cooler ball-rooms and fantastically-lighted dining-tables. And when, after coffee, the question passes between my lords and gentlemen: "Who is your electrical engineer?"—then a word, or a reference to this same thin pamphlet with the signal-light of the Parliament House shining from it, may be worth a good deal of scientific talk.

Electrical Congress at Chicago.—A meeting of the Advisory Council of the Chicago World's Congress of Electricians was held at the rooms of the American Institute of Electrical Engineers, New York, on January 17. The following gentlemen were present: Dr. Elisha Gray, chairman, Prof. Wm. A. Anthony, Prof. Charles R. Cross, Dr. Louis Duncan, Dr. William Geyer, Mr. Carl Hering, Mr. George A. Hamilton, Prof. F. B. Crocker, Mr. A. E. Kennelly, Mr. T. D. Lockwood, Mr. T. C. Martin, Mr. Geo. M. Phelps, Dr. M. I. Pupin, Mr. R. W. Pope, Prof. H. A. Rowland, Mr. Herbert Laws Webb. Mr. H. L. Webb was elected secretary of the meeting, in the absence of Prof. Carhart, permanent secretary of the council. The preliminary reports of the English and American committees, already made public, were received. It was resolved that the Electrical Congress of 1893 shall consist of two chambers, of which the legislative chamber shall decide on units, names of units, and standards, and shall consist solely of delegates named by their respective Governments. A committee was appointed to determine the total number of official delegates and their apportionment to the various countries to be represented. The following apportionment of delegates was made by the committee, whose report was adopted by the meeting: Great Britain 5, France 5, Germany 5, Austro-Hungary 5, United States 5, Belgium 3, Italy 3, Switzerland 3, Holland 2, Denmark 2, Norway and Sweden 2, Russia 2, Spain 2, Portugal 1, British North America 1, Australian Colonies 1, India 1, Japan 1, China 1, Mexico 1, Brazil 1, Chili 1, Peru 1, Argentine Republic 1; making a total of 55 official delegates. It was also resolved that a committee on invitations be appointed by the chairman, this committee to consist of five members who shall select and recommend to the chairman the names of electricians, electrical engineers, and others, who shall be members of the Electrical Congress, the said committee to co-operate with the foreign committees. It was further resolved that in addition to invitations to deliberating and voting members of the congress, a general intimation shall be extended through the journals or otherwise that the meetings will be open to the public for attending the proceedings, but not for taking part therein. It was resolved that a committee on programme and papers be appointed by the chairman. This committee shall consist of eight members, whose duty it shall be to invite, receive, and consider papers and other documents relating to the work to be done by the congress; and it was further resolved that it shall be the duty of this committee to formulate a programme for the congress. It was resolved that the reports of the English and American sub-committees which were received at the meeting should be referred to the committee on programme and papers, and that the committee confer with the English committee as fully as possible, and with such other foreign committees as may be formed. The Electrical Congress of 1893 will last one week, beginning on August 21st. The question of charging a fee for membership is left to the Executive Committee.

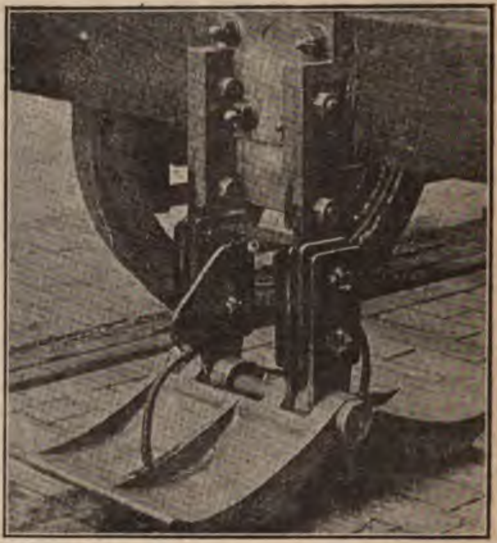
THE LIVERPOOL OVERHEAD RAILWAY.

(Continued from page 106.)

Passing now from the constructive details of erection, permanent way, etc.—as not involving points of such interest to our readers as the system of operating the line by means of electric motors—we may conclude our description of the ironwork and superstructure generally of the line, by illustrating one of the curves traced alongside the dock walls where, in consequence of the conditions thus existing, the standard type of span is considerably departed from. It will be noticed from the engraving that, instead of light transverse lattice bracing from column to column, the arched floor is supported by an ordinary plate girder of a wider span than usual. Otherwise, however, the structure closely resembles the standard erection already described.



View of Superstructure—Span No. 68.



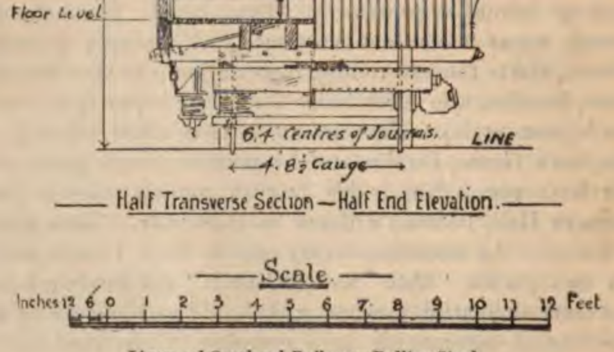
Collector at End of Carriage Bogie Truck.

The extreme hinder end of the erecting frame and truck may be seen in the same engraving, in position for laying down a span of flooring, etc. This truck and frame, at its front end, was carried by movable iron columns, and was thus moved along as the work progressed.

Upon the rails that are carried by the entire overhead structure constructed in the manner and of the design so far detailed, there are destined to run a series of trains, propelled electrically, and each consisting of two cars coupled together. Each car is mounted upon a couple of four-wheeled bogie trucks of the ordinary American pattern, and upon one axle of the bogie at each end of the train—that is, on the outer bogie of each car—is fixed an electric motor of sufficient strength—70 h.p. to 100 h.p.—to propel the train. The motor armature is mounted upon the axle direct, and all gearing or coupling arrangements are therefore avoided. Of course, this method of direct action between motor and axle implies a slow-running armature, but the loss in efficiency of the whole motor, or the disadvantage of its considerable weight, incurred by its relatively low speed, is probably far more than counterbalanced by the absence of all power-wasting gears, besides which the repairs are lessened and likelihood of breakdown reduced owing to the more simple design. At a speed of 30 miles per hour, which is probably the utmost velocity that these trains in daily working will be able to attain, because of the frequent starting and stopping (there being no less than 13 stations on the length of six miles or so now open), the motors do not run faster than about 300 revolutions per minute, so that their maximum speed can hardly be considered enormous even for machines of such power. The design, however, shows that throughout both the magnetic and the electric circuits these motors are calculated for endurance under heavy strains. We shall be able to give further details of them—with illustrations showing the type adopted and the method of suspending each motor to the truck-frame, etc.—in our next issue.

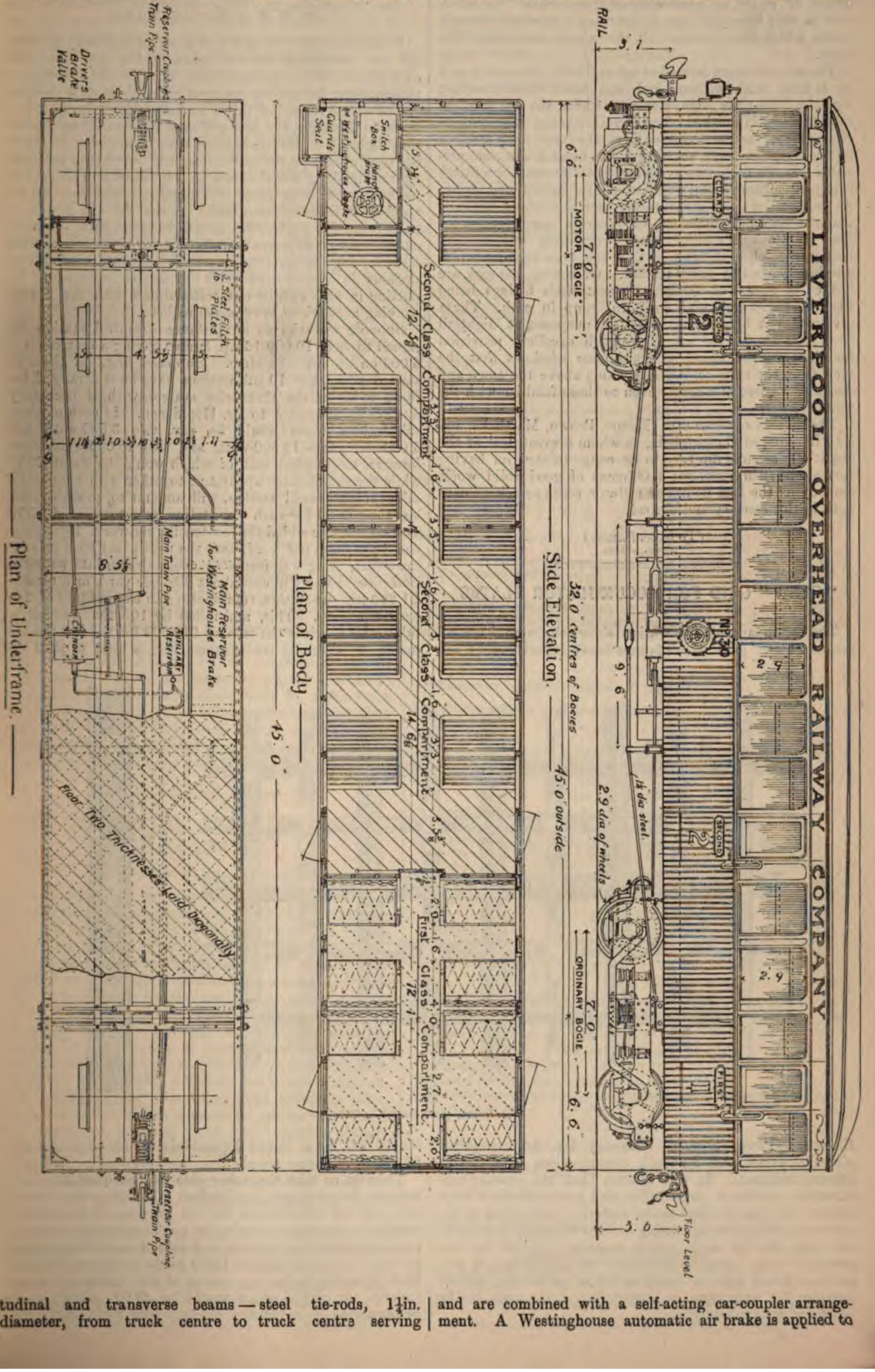
Returning, now, to the cars themselves, it may be said with truth that they deserve more than a passing notice. These carriages embody the best points of American and English designs in the direction of rolling-stock; they are fitted with transverse seats and a centre gangway, thus greatly resembling the ordinary passenger car as used throughout the United States. Each car, however, is divided into two classes—first and second—and the seating accommodation in the two compartments thus formed is respectively for 16 and 41 persons. A further differentiation from standard American practice consists in the use of doors opening in the sides of the carriage, instead of end platforms; so that the ease and quickness with which trains of passengers are loaded or unloaded under the accepted English method may be thereby fully secured.

The principal dimensions and details of construction of these cars will be seen quite clearly on the accompanying full-page illustration, which represents a side elevation, plan of body, and plan of underframe with the floor broken away to show the design and arrangement of steel frame adopted. Each car measures outside in length 45ft., in width 8ft. $9\frac{1}{4}$in., and in height from rail level 11ft. $0\frac{5}{8}$in. The centres of bogie trucks are 32ft. apart; each truck has a wheel centre distance of 7ft., the overhang of car body from centre of truck being 6ft. 6in. The bogie-truck frames are of pressed steel; the wheels—2ft. 9in. diameter—have wrought-iron spokes, steel tires and axles, and cast-steel


8. 9¼
4. 2⅛
4. 11⅛
11. 0⅝
Floor Level
6.4 Centres of Journals.
LINE
4. 8½ Gauge
Half Transverse Section—Half End Elevation.
Scale
Inches 12 6 0 1 2 3 4 5 6 7 8 9 10 11 12 Feet

Liverpool Overhead Railway—Rolling Stock.

axle-boxes. The car body underframe is of 4in. by 9in. angle iron, strongly braced both by longitudinal and transverse beams — steel tie-rods, 1¼in. diameter, from truck centre to truck centre serving to brace it upwards, bowstring fashion. The buffers are placed centrally, as in nearly all the American rolling-stock, and are combined with a self-acting car-coupler arrangement. A Westinghouse automatic air brake is applied to



Liverpool Overhead Railway—Rolling Stock.

every wheel of the train, and as an extra precaution the driver, or guard, or conductor, or "motorneer" (or whatever he may be called), has at command a mechanical screw brake, which also operates all the wheels throughout the train.

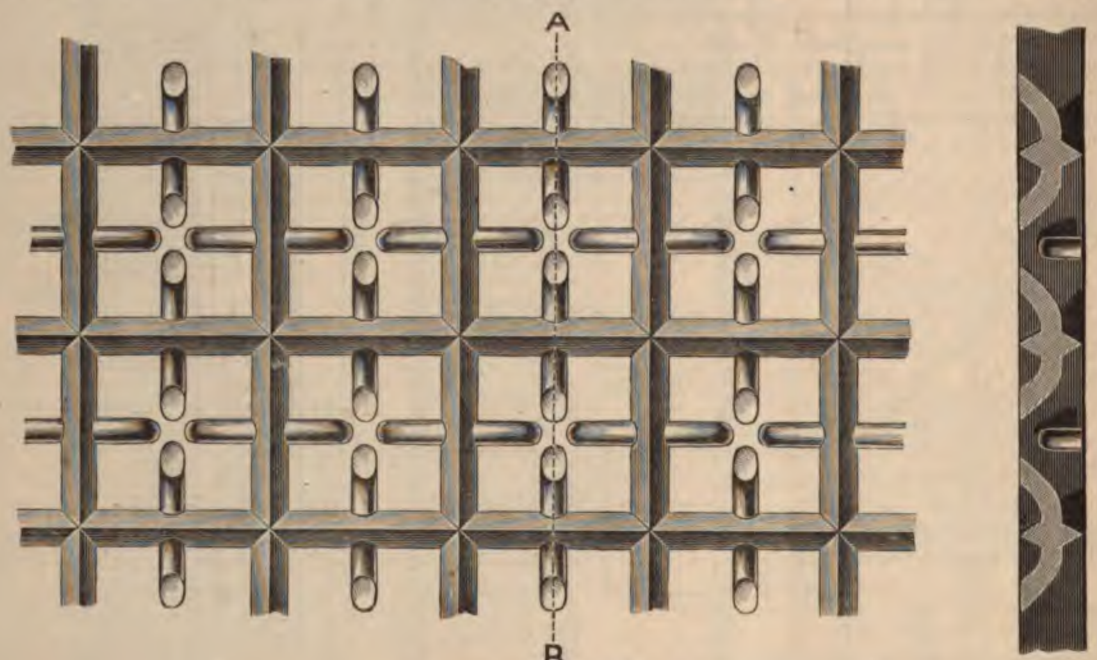
The car bodies are framed of oak and teak; internally each car is lined with wainscot oak and black walnut banding for the first-class compartment, whilst the second-class compartment is finished off with yellow pine. The second-class seating accommodation is of the type now familiar on the "garden-seat" omnibuses, but fixed backs are provided: in the first-class compartment the seats are elaborately upholstered and finished off in carved mahogany. At one end of each car, directly over the motor bogie, is placed a very neat little cab or separate compartment for the "motorneer," with electric regulating switchboard, brakes, etc., close at hand, so that the train may be under absolute control at every instant. Of course, the cars are lighted by means of electricity: neat little fittings being fixed to the ceiling, with an 8-c.p. lamp in each. These give sufficient light for all practical purposes, at nightfall or in fog; by day the cars have such excellent provision for light in the shape of continuous windows that the view from the train as it glides along above the town and docks will prove of interest even to those familiar with the route.

The makers of these cars (Messrs. Brown, Marshalls, and Co., Limited, of Birmingham, to whom a great deal of the credit of design is due) are to be congratulated on having turned out such excellent specimens of good solid work, embodying the best points of railway rolling-stock as used both in this country and abroad.

(To be continued.)

"CLAW" GRID FOR ACCUMULATOR PLATES.

The accompanying illustration shows the new form of patent "claw" grid which is now being introduced by the Electrical Power Storage Company for their negative plates generally, and for both denomination of plates in selected instances. It will be seen that the peculiar construction enables a large pellet, and consequently a large amount of paste or other active material, to be used in the electrode, while the conducting surface is largely increased; and the grip for such active material applied by the peculiar "claw" shape ensures that the porous lead or peroxide is firmly held in position, while permitting perfect freedom for expansion or contraction in the mass of the pellets of active material.



New "Claw" Grid for E.P.S. Cells.

TRANSFORMERS AND SUB-STATIONS.

BY W. H. TRENTHAM, M.I.M.E.

In the rush to adopt new and so-called improved systems, old and comparatively well-beaten paths are sometimes abandoned without due consideration. Several instances of this tendency have lately occurred in central-station designs

The writer requiring, in the course of his ordinary avocations, to think out the best and most economical method of town-lighting on the alternating system, has been forced to the conclusion that the now apparently universally accepted plan of banking transformers in combination with a network of low-tension mains is altogether a mistake. In his opinion, it is more economical to use the old system of transformers in a somewhat modified arrangement—namely, one to every half-dozen houses, instead of each establishment having its own transformer—than to employ sub-stations in conjunction with expensive apparatus for putting in and cutting out transformers with the accompanying network of low-tension mains.

Suppose we take as an instance a central station designed to feed 10,000 16-c.p. lamps, having a maximum of 6,000 on at any one time. Suppose, first, on the sub-station plan, that 10 sub-stations have been arranged for, these to be on the three-wire system, with, if necessary, due acknowledgment to Dr. Hopkinson. In each of these sub-stations there would be, say, two 3,000-watt, two 6,000-watt, two 12,500-watt, and two 20,000-watt transformers, the capital cost of which would be about £255, while the change-over apparatus, together with regulating-cables from central station, will amount to, probably, not less than £500 for each sub-station, or a total of £7,550. To this must be added the low-tension network. Reckoning one 8-c.p. lamp per yard, and the mains laid both sides of the street, using well-insulated cables drawn into wrought-iron pipes, these will cost about 20s. per yard, or a total of £1,200 per sub-station, representing an expenditure of 20s. per 8-c.p. lamp. This, multiplied by 10—the number of sub-stations—gives the sum of £12,000 for the low-tension mains, or including transformers, etc., a total of £19,550 for 12,000 8-c.p. lamps lighted simultaneously, or, say, 20,000 8-c.p. lamps wired.

Then let us take the other side of the question—with separate transformers not banked. Dividing the district into, say, 10 sub-districts for the purpose of more easily comparing the two methods, the same average of one 8 c.p. per yard should be taken on each side of the street, making, as before, a total length of 1,200 yards to each sub-district. Each side may be fed by means of six 3,000-watt transformers, the cost of which would be £180. These would be connected to concentric cables, which, including pipes, laying, junction-boxes, etc., and high-tension feeders to transformers, would cost about £450 per sub-district, and adding outlay on transformers, a total of £6,300 for the 10 sub-districts on the high-tension system, as against £19,550 on the sub-station and low-pressure network system.

Now let us see how the advantage of low first cost is counterbalanced by coal consumption. We may take the consumption of energy at 20 units per 8-c.p. lamp wired, or 400,000 per annum; the loss in feeders and secondary mains may be neglected, as it will be practically the same in both systems. In the case of sub-stations, if the average efficiency be 92 per cent., which is probably rather high, the coal consumption at 8lb. per unit (which should not be exceeded if transformers are properly banked) will be 1,543 tons per annum. On the other hand if the area were divided into sub-districts as explained, with 3,000-watt transformers feeding into secondary mains, the coal consumption would not be seriously increased. I have before me a table of efficiencies of transformers made by a leading company where the loss of watts on open circuit is given at 3·3 per cent. of full load; perhaps it will be better to take it at 5 per cent.; then to show the contrast more forcibly we will take the average efficiency at 85 per cent., which will bring our coal consumption up to 1,752 tons. Pricing this at 22s. per ton, it gives a total coal cost of £1,697. 6s. and £1,927. 4s. respectively, showing a yearly loss of £229. 18s. in the latter system. It must be remembered, however, that the capital cost of the former system is £13,250 more, and that, unfortunately, a depreciation of at least 7½ per cent. must be allowed on this amount. This, in addition to 6½ per cent. interest and sinking fund on the extra outlay of £13,250, represents about £1,855 a year, against the increased coal consumption of £229. 18s. It is thus obvious that, unless the average efficiency of transformers falls to less than 36 per cent., there can be no benefit in employing sub-stations, with their accompanying complications, where coal is worth 22s. per ton. In cheaper coal districts, the advantage on the side of sub-districts is, of course, far more pronounced.

In giving the above facts, the endeavour has been to entirely avoid anything in the way of complicated calculations, but merely to state the matter as plainly as possible, in order that it may be easily understood by town councillors and members of other local authorities and their advisers, to enable them to form an idea of the suitability of different systems when deciding on the best method of carrying out electric lighting works under their provisional orders.

SOME MECHANICAL AND ELECTRICAL ANALOGIES.*

BY DR. F. BEDELL AND DR. A. C. CREHORE.

No phenomena are so readily comprehended as those which may be compared directly with facts that are familiar, and no reasoning is so quickly grasped as reasoning "by analogy." The analogies between certain mechanical and electrical relations are so striking that when either relations are understood the others follow, and from the laws of mechanics we can readily write those of electricity. The process is a reversible one, and the electrician can with equal ease step over into the realms of dynamics. To enable one to reason accurately in this manner, and to reach definite results with absolute certainty, it is necessary to give with exactness the fundamental relations of mechanics and electricity. The following tables are, therefore, given, showing the analogies between linear motion, motor of rotation, and the electric current. Starting a current of electricity in a circuit is analogous to imparting motion to a body, and requires an impressed force. This force must overcome the resistance (electrical resistance corresponding to that of friction), and the inertia of the mass or current.

In the case of the electric current this inertia is called "self-induction." A revolving flywheel may well represent the flow of electricity, its velocity corresponding to the current, its moment of inertia to the coefficient of self-induction, and the friction to ohmic resistance.

TABLE I.—Linear Motion.

Notation.

1. Time = t.
2. Distance = s.
3. Linear velocity = $v = \frac{ds}{dt}$. $ds = v\,dt$.
4. Linear acceleration = $a\frac{dv}{dt} = \frac{d^2s}{dt^2}$.
5. Mass = M.
6 Momentum = M v.

Frictional Resistance.

7. Frictional resistance = R.
8. Force to overcome resistance = $F_R = R\,v$.
9. Energy expended in overcoming resistance in the time $dt = d\,W_R = F_R\,ds = R\,v^2\,dt$.

Inertia.

10. Force to overcome inertia = $F^1 = M\,a = M\frac{dv}{dt}$.
11. Kinetic energy acquired in the time $dt = d\,W^1 = F^1\,ds = M\,v\frac{dv}{dt}dt$.
12. Kinetic energy = $W^1 = \int_0^v M\,v\frac{dv}{dt}dt = \frac{1}{2}M\,v^2$.

Insertia plus Resistance.

13. Total force applied = $F = F_R + F^1 = R\,v + M\frac{dv}{dt}$.
14. Total energy supplied in the time $dt = d\,W = d\,W_R + d\,W^1$; or, $F\,ds = F_R\,ds + F^1\,ds$; or, $F\,v\,dt = R\,v^2\,dt + M\,v\frac{dv}{dt}dt$.

TABLE II.—Rotary Motion.

Notation.

1. Time=t.
2. Angle=ϕ.
3. Angular velocity=$\omega=\frac{d\phi}{dt}$. $d\phi=\omega\,dt$.
4. Angular acceleration=$\alpha=\frac{d\omega}{dt}=\frac{d^2\phi}{dt^2}$.
5. Moment of inertia=I.
6. Angular momentum=I ω.

Frictional Resistance.

7. Frictional resistance=R.
8. Torque to overcome resistance=$T_R = R\,\omega$.
9. Energy expended in overcoming resistance in the time $dt = d\,W_R = T_R\,d\phi = R\,\omega^2\,dt$.

Inertia.

10. Torque to overcome inertia=$T^1 = I\,\alpha = I\frac{d\omega}{dt}$.
11. Kinetic energy acquired in the time $dt = d\,W^1 = T^1\,d\phi = I\,\omega\frac{d\omega}{dt}dt$.
12. Kinetic energy = $W^1 = \int_0^\omega I\,\omega\frac{d\omega}{dt}dt = \frac{1}{2}I\,\omega^2$.

Inertia plus Resistance.

13. Total torque applied=$T = T_R + T^1 = R\,\omega + I\frac{d\omega}{dt}$.
14. Total energy supplied in the time $dt = d\,W = d\,W_R + d\,W^1$; or, $T\,d\phi = T_R\,d\phi + T^1\,d\phi$; or, $T\,\omega\,dt = R\,\omega^2\,dt + I\,\omega\frac{d\omega}{dt}dt$.

TABLE III.—Electric Current.

Notation.

1. Time=t.
2. Quantity=q.
3. Current = $i = \frac{dq}{dt}$. $dq = i\,dt$.
4. Current acceleration = $\beta = \frac{di}{dt}$.
5. Coefficient of self-induction = L.
6. Electromagnetic momentum = L i.

Ohmic Resistance.

7. Ohmic resistance = R.
8. E.M.F. to overcome resistance = $e_R = R\,i$.
9. Energy expended in overcoming resistance in the time $dt = d\,W_R = e_R\,dq = R\,i^2\,dt$.

Self-induction.

10. E.M.F. to overcome self-induction = $e^1 = L\,\beta = L\frac{di}{dt}$.
11. Energy acquired by the magnetic field in the time $dt = d\,W^1 = e^1\,dq = L\,i\frac{di}{dt}dt$.
12. Energy of magnetic field = $W^1 = \int_0^i L\,i\frac{di}{dt}dt = \frac{1}{2}L\,i^2$.

Resistance Plus Self-induction.

13. Total E.M.F. applied = $e = e_R + e^1 = R\,i + L\frac{di}{dt}$.
14. Total energy supplied in the time $dt = d\,W = d\,W_R + d\,W^1$; or, $e\,dq = e_R\,dq + e^1\,dq$; or, $e\,i\,dt = R\,i^2\,dt + L\,i\frac{di}{dt}dt$.

---

* Physical Laboratory, Cornell University, January 16, 1893.

A study of the tables will make these analogies more clear. It is to be noted that the flywheel or moving mass, in slowing down, gives back its kinetic energy, and the wheel is carried on, after the impressed force is removed, until this is entirely consumed in overcoming friction. Similiarly, when the current diminishes upon the removal of the impressed E.M.F., the energy stored in the magnetic field is restored to the circuit, and the current keeps flowing until the energy is entirely used up in overcoming the ohmic resistance.

These analogies cannot be considered as rigorous proof. The truth of the relations here given for the electric current has been fully established, and may be found in the introductory chapter to our work on "Alternating Currents." Other striking analogies will suggest themselves, but space will not permit calling attention to any but the most fundamental ones given above.

ONE USE FOR THE TELEPHONE.*

BY F. S. MARSH.

The writer had experienced some difficulty on several occasions in signalling in the usual way by electricity to the engine-driver on the surface when anything had temporarily gone wrong with the underground endless-rope haulage, owing to the fact that on the signal to stop being given, one of the many workpeople along the level not knowing anything was wrong, and sometimes for mischief, rang the signal to start. This happened more than once, with unpleasant consequences. The engine-driver, not knowing who was ringing the bell, of course acted on the signals received, and in the case of the rope being out of the balance-wheel, train off the road, or like mishaps, much damage was soon the result. No code of signals the writer could devise would deal with this difficulty, and, as anyone along the level could give the signal to start, the engine-driver never knew either who gave it, or, if anyone was tampering with, and making at such a time a dangerous use of it.

The only satisfactory solution of the difficulty could be found in a system of signals whereby anyone along the level could signal "stop" in case of accident, but only one man could give the word to start. This, it will be readily seen, is met by the use of the telephone. An occasion arising for stopping the engine, the ordinary code signal "one" is given, followed immediately by a prearranged signal (which all working on the road should know), say, 10 strokes of the bell; on receiving this signal the engine-driver, who has stopped the engine, takes the telephone off its hook, and listens for instructions from the only man who, carrying the transmitter, can give them; he is told what is wrong, and he now knows exactly what he is about, and what is of equal importance, the men below know that it is safe for them to do anything about either wheels, trams, ropes, or other gearing, no matter how they may be entangled. When all is right the engine-driver is acquainted with the fact, and told he is about to have the signal to start; he then replaces the receiver on its hook and waits for the signal, after receiving which he goes on with his work, taking instructions by the authorised code. There is here no possibility of mistaking signals, and all work with a sense of security unknown when using code signals alone. There are reasons why an automatic switch is necessary. Were the telephones below ground connected to the signal wires whilst the battery is on circuit the magnet would be injured, and were it other than automatic the engine-driver might forget to turn the switch; directly the circuit is closed by removing the telephone from its hook no code signal can be given, so the annoyance of continuous ringing is effectually stopped. Replacing the instrument on its hook at once brings the ordinary signals into use again.

Another useful purpose served by the automatic switch is that on removing the telephone (when work for the day ceases), and letting it hang by its suspension cord (provided to preserve the insulated wires from injury), the electric circuit being closed, the battery power is saved. This can, of course, be equally well effected by taking out one of the battery zincs, and in other ways.

For some purposes it is convenient at times for several persons to carry with them a transmitter. Deputies, who in case of serious personal injury to workpeople, can telephone for the stretcher, thereby gaining in many cases, depending on distance, half an hour or more time in removing the injured and obtaining medical advice. Where rope-splicing is being done, or ropes are being changed, it is often a gain in time when direct communication can be maintained with the surface, or any intermediate point; for it must be remembered that two telephones may be hooked on to the ordinary naked wires at any point along the line of wires, the only additional arrangement necessary being predetermined parts of the road, where the person using the instrument must listen, and the battery being off there can be no call bell used. Other uses, depending on local circumstances in any particular mine, may make the telephone a valuable adjunct.

WATCH RECEIVER

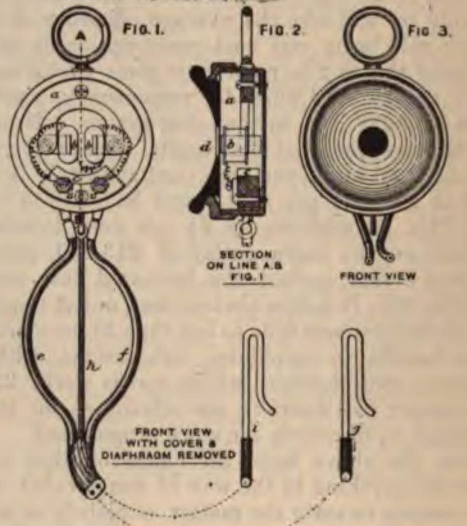
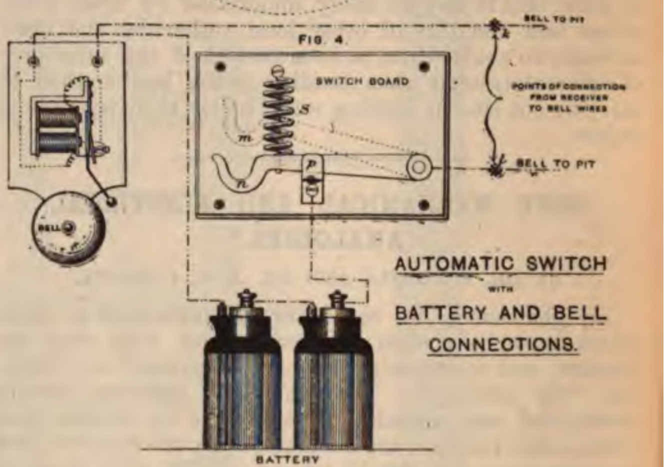


FIG. 1.
A
a
e
h
f
FRONT VIEW WITH COVER & DIAPHRAGM REMOVED
FIG. 2
a
d
b
SECTION ON LINE A.B FIG. 1
FIG 3.
FRONT VIEW
i
j



AUTOMATIC SWITCH
WITH
BATTERY AND BELL
CONNECTIONS.

The instrument selected by the writer, chiefly on account of its portability, is the "watch receiver" (answering equally well as a transmitter), which is a modification of the Bell telephone. Fig. 1 shows a front view of the instrument, with cover and diaphragm removed, in which *a* is a horseshoe magnet, *b b* are the bobbins wound with silk-covered copper wire, *c* insulating material, *d* (Fig. 2) the diaphragm of thin ferrotype iron; *e* and *f* insulated wires from the two poles of the magnets secured by the binding screws, G G, and joining in a twin cable at the end of the suspending cord, *h*. The twin cable, 24in. long, is provided with two brass hooks, *i j*, on the instrument for underground use. For connecting on to the ordinary signalling wires it is immaterial which hook goes on which wire. An arrangement of an automatic switch for use in the engine-house is shown in Fig. 4. The cable terminals are joined permanently to the ordinary signal wires at *k l* on the pit side of the switch, which is shown by dotted lines in closed circuit, *m*, and in open circuit at *n*—that is, when the weight of the telephone, adjusted to overcome the tension of the spring, S, brings the hook in electrical contact at *p*. The receiver for use below ground is best carried in a leathern bag, large enough to hold the cable attached (24in.), all of which will go in the waistcoat pocket, and as it weighs under half a pound it is no inconvenience.

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* Paper read before the Chesterfield and Midland Counties Institution of Engineers.

The telephone, arranged as described, has now been in use at the Birch Coppice Colliery for several months on three separate roads, being, roughly, 1, 1¼, and 2 miles long respectively, and has answered very well. With long lines it might be necessary to use a microphone, but the "Watch" or "Ader" modifications of the "Bell" telephone, answer all ordinary requirements. Whilst not claiming this as the best system in all cases for signalling it may be suggested as one use for the telephone.

ELECTRIC FOUNTAINS.

A full description is given in the *Electrical World* for the 21st ult. of the electric fountains at the Chicago Exhibition. The first electric fountain was that of Sir Francis Bolton, who patented the arrangement broadly in 1884. Mr. Dwight Wiman purchased the American patents for his father, Mr. Erasmus Wiman, and with the assistance of Mr. Luther Stieringer, now consulting engineer to the World's Fair, put it into successful operation on Staten Island, at the cost of 40,000dol. The forms used mostly are the wheatsheaf, criss-cross fence, centre jet, and rocket. The jets of water varied by steam seem to be most effective when illuminated with the brilliant coloured rays of the electric light. An allegorical group, representing Columbus's ship, designed by Mr. McMonnies, will be a prominent feature of the electric fountains at the exhibition, and virgins, sea-horses, and other groups make an imposing sight, a view of which, drawn by Mr. Outcault, is presented as a double-page illustration. The fountains will be illuminated by 38 arc lamps of 100 amperes each, the controlling levers being placed in chambers beneath the pools, but directed by electric signals from the tower of the machinery hall. The jets will all be hidden by artistic bronze foliage, the water seeming to spring into sight from an aquatic floral piece.

LONDON INSTITUTION.

The third and last of the series of lectures on electric lighting by Dr. Silvanus Thompson was given last Friday at the London Institution, the subject on this occasion being distribution and measurement. There were two questions, said the lecturer, that the electrical engineer was constantly asked. The first was always "Do you not think that electricity is still in its infancy?"—an irritating and inevitable question to which he felt inclined to adopt the method used by a friend of his in America, who carried little counters ready to hand out bearing the words: "No! Electricity is not in its infancy." The second question was, "Will there ever be such a thing as a reliable electric meter?" The reply he gave was that up to the present there exists no reliable gas-meter, while we have already reliable electric meters. No gas-meter indicated one-tenth part as correctly as the present electric meters in use at central stations. The City of London Company, for the third time, had supplied the hall with current, and he learnt they had just started further dynamos which would supply 10,000 to 15,000 more lights, the current from which was led to a transformer in the body of the theatre. He had also present different forms of meters. The history of the development of meters started from Edison's chemical meter, which at one time was largely used in America. The integrating meters were now preferred, among the earliest to suggest them being Jas. Thomson, whose globe-disc-cylinder meter was effective but elaborate, the first ones costing £90 apiece. A more modern form of integrating meter, by Cauderay, was commercially possible. Mr. Reckenzaun had also worked long to produce a simple practical meter of this description. The Aron meter, on a principle suggested by Ayrton and Perry some 10 years ago, utilised the difference in time produced by comparing an electrically-affected pendulum with an ordinary pendulum swinging freely. This meter was effective, but had the defect that it required a man to go round and wind up the clockwork once a fortnight. Ferranti's mercury rotating meter was largely used, and had proved accurate. The Thomson meter, one of which was on the table, was one of the latest and most perfect. One ingenious adaptation of the pendulum meter with few works integrates by making one pendulum drive the hands and the other the clock face, the difference measuring the amount of ampere-hours. Tests made showed these meters were marvellously good, giving a high degree of accuracy. With regard to cost of supply the question of efficiency was the most important. Now the gas-works always pass more gas from the works than is accounted for in the meters. The gas leaks away. But at the West-end electric stations, supplying current for 20,000 lamps, there was often not leakage enough to light even one lamp. From the electrical point of view the efficiency was very high—how with the coal efficiency? One pound of coal would produce 6,800 heat units, one heat unit equalling 1,390 foot-pounds; each pound, therefore, can yield as heat energy 9,452,000 foot-pounds. In 8lb. of coal there are, therefore, 75,616,000 foot-pounds. At Kensington, a well-engineered station, about 8lb. of coal are used for each unit of electricity, the unit being about 1⅓ h.p., or 2,640,000 foot-pounds—2½ million out of a possible 75 million—not much over 3 per cent! Here is a great leakage somewhere. What becomes of the other 97 per cent. of the heat energy? If electric lighting ever becomes as cheap as gas it will be by saving more and more of this wasted heat energy. In this respect it looks as if something were "in its infancy." The loss is not in the mains to any great extent, nor is it in the dynamos—they are wonderfully effective. Belts and shafting cannot account for 97 per cent. The answer is that one-quarter goes up the chimney, more goes in radiation from the pipes and boilers before the steam gets to the engine, and then the engine wastes three-quarters of that. The fact is that the steam-engine is wretchedly inefficient. It is not electricity, but the steam-engine that is "in its infancy." However, 8lb. of coal do not cost 8d., the price per unit of electricity—there is labour and superintendence, cost of collection, depreciation of machinery, and dividends to shareholders. The aim of electrical engineers is to bring the total cost per unit down to 4d., and then electric light will be able to compete with gas. At present the great difficulty the engineers have to contend with is the variation of the load. Plant must be provided to supply current for the enormous increase in demand that occurs from 4 to 6 o'clock in the evening, and three-quarters of this plant is kept standing idle during the day. What is wanted is the introduction of accessory means of using electricity in the daytime and at night. This will be in the use of electric motors, and of heating and cooking by electricity. Already alternate-current motors had been successfully made for small work, and a motor could be seen at work on the lecture table, driving a ventilating fan at enormous speed. Electric heaters to boil water, cook pancakes, or grill chops, could also be seen; and a neat silver-plated heating arrangement could be put inside a kettle or boiler, or even inside a pudding for cooking. The piano itself might, as they could hear from the one present, be played by electricity. What to-day is a scientific plaything will become the useful everyday means of work in a year or two He hoped to see whole factories run exclusively by electricity, and especially the shops of small masters, such as those in Clerkenwell and Soho, who cannot go to the expense of a steam-engine, or even a gas-engine, of their own. Every day is bringing us nearer to the time when electricity will be made cheap, when the cost will be so reduced that electric light, heat, and power would be within the reach of all. The dreams of past years and the toys of yesterday are fast becoming the hard facts of to-day.

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

The general meeting of this Company, which was adjourned in December, was to have been held on Tuesday at Winchester House, Old Broad-street, E.C. Owing, however, to the serious illness of the chairman (Lord Albemarle) and to the absence on the Continent through illness of other Directors, a circular had been issued to the shareholders stating that the meeting would be formally held on the 31st January, and that it would be again adjourned until the 14th February. The circular also stated that the balance-sheet and report would be forwarded to the shareholders next week, so that the latter would have time to examine and consider the accounts.

Mr. James Pender, who occupied the chair on Tuesday, said that the secretary hoped to send out the report and balance-sheet on Friday next (to-day).

A **Shareholder** expressed the hope that the profit and loss account would be a little fuller than last year.

The **Chairman** thought that the shareholders would have a very full profit and loss account.

The **Shareholder** remarked that last year the items were very much summarised, and the shareholders were dissatisfied.

The **Chairman** observed that the accounts had been gone into very fully by the auditors. They had had difficulties. Their first secretary was drowned, and the second one went "off his head." The items, would, however, be explained in detail. In reply to other questions, the Chairman said that he did not know, in the event of the absence of the chairman at the forthcoming assembly, whether the meeting would be again adjourned. He believed the reason Mr. Paxman left the Board was because he was busy elsewhere, and found it very difficult to attend the meetings. He did not know whether Mr. Paxman had sold out his shares.

Mr. Immisch seconded the motion for adjournment, and the meeting was postponed until February 14.

Japan.—The *British Journal of Commerce* is the first English journal to issue a Japanese edition printed in Japanese, to form a medium of intercourse and advertisement for British goods.

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ELECTRIC RAILWAY CARRIAGES.

Unless we are greatly mistaken, it was the electrical world of this country that first enjoyed appreciation of the keen sarcasm offered by the saying: "Inertia is of two kinds, the inertia of progress and the inertia of rest," though probably most men have realised the fact itself ever since the beginning of civilisation. As applied to the railway companies of Great Britain, the remark has greatest relevance on the second head; and the reason is neither obscure nor far to seek.

Red-tapeism, perhaps, forms one portion of it; the difficulty which any progressive spirit finds in getting its own way, is another portion. The question of expense arises, in addition, to act as a bar to any rapid change or alteration—effecting however great an improvement—so long as heavy outlay is thereby rendered necessary. These and similar reasons have been sufficient during the last generation or so to account for little or no substantial change in the general design or type of conveyance employed by our railway companies for the use of passengers. Of course, the cream of such traffic always receives continued attention from the authorities: Pullman cars and dining saloons are provided for those who can afford to pay suitable fares, and the standard of accommodation in general has been raised almost universally. The fundamental idea of a railway carriage, however, is still that of the stage-coach, taking the mass of our rolling-stock; and owing largely to the inertia above mentioned, it looks as though the same idea would continue indefinitely.

But the other kind of inertia has begun to act; and notably so in the railways that here and there are showing the public of travellers what electricity can do in the way of speedy, comfortable, and economical means of transmit. These lines have practically offered an open field for the introduction and development of new ideas and plans more consonant with modern tastes than those of fifty years ago; and the consequence is that notable differences are to be seen in many details, and even in the fundamental features. As regards the types of rolling-stock employed, this is particularly noticeable.

On the City and South London Railway the trains are each practically of the "vestibule" pattern, there being a continuous passage throughout. The seats are arranged differently to those of our ordinary railway carriage, being longitudinal instead of transverse, though still facing one another. The "compartment" idea is totally done away with, except so far as each carriage may be considered a compartment, because the end doors are closed when the train is in motion. As a type of rolling-stock, however, the City and South London carriage offers a most decidedly changed aspect to that of the accepted vehicle on a steam railroad; and in its absolute freedom from difference in class—*i.e.*, first, second, or third—gives free scope to the democratic imagination.

The carriages employed on the Liverpool Overhead Railway—a description of which appears elsewhere in this issue—are even more decidedly altered from the old style, largely, perhaps, owing to the new conditions offering a free hand to improvements. The absence in their case of any locomotive—the two cars constituting a train being self-contained, or "automobile," so far as the driving motor is concerned—is a striking feature of the vehicles on this line; they preserve, however, some of the class distinctions by conveying first and second class passengers.

Of course in both these cases we have what are practically isolated lines—without connection with other railroads, and therefore capable of employing rolling-stock of the most approved design. It is not, however, absolutely essential to change all at once the entire stock of an ordinary railroad as it now exists: a gradual alteration might surely be effected—in many cases is being effected; but the inertia of rest is great, and progress correspondingly slow.

Without doubt the examples set by the electric railways will be followed to a large extent, not only by the new electric lines that are projected or being built, but also by our steam railroads so far as may be possible for their officials to comply with public demands on one side and questions of economy on the other. If the travelling public continue to appreciate the new types of rolling-stock, there is no doubt that their wider adoption will be secured.

COMMUNICATION WITH LIGHTHOUSES.

England is a maritime nation. Its floating wealth is enormous. Its floating population is also very large. The seas around its coast are dangerous, and annually take a heavy toll of ships and men. The former can be replaced, the latter never. Any proposal, then, to assist in saving life or vessel should have ready attention. Lighthouses and lightships gird our shores, but up to the present have been able to play one part—that of warning the ships of their dangerous position. It has long been recognised that something more was required—the ability to call aid as well as to give warning. The aid of electricity will be summoned to fulfil this want—in fact, it has been tentatively tried; and now there seems to be some hope of its being systematically adopted. For some time a Royal Commission has been sitting, and its first report was issued on Wednesday last. As might have been expected, its more important suggestions are in connection with light-vessels rather than with lighthouses. Many of the latter are on the edge of the mainland, and it did not want a Royal Commission or half an hour's consideration to come to the conclusion, that, wherever possible, the lighthouses should be in telegraphic communication with the general telegraphic system of the country. The expense of such connection is comparatively small. The Commission recommends that some sixteen shore lighthouses be so connected, the expenses varying from £30, the lowest, to £265, the highest. When the lighthouses are on islands or isolated rocks the cost is greater, though in these cases the difficulties to be overcome are much less than with the light-vessels. In the latter case, some men have gone so far as to deny the practicability of electrical connection, while others have all along contended that it was merely a matter of cost; we agree with the latter. A light-vessel may have a vertical rise and fall of any number of feet—it is not beyond the power of the electrical engineer to provide for this; it may also swing round to any extent, provision for which must be made. According to the estimates of the Commission, five light-vessels, one pile lighthouse, sixteen shore lighthouses, and three island lighthouses can be electrically connected for about £20,000—a sum hardly worth considering when the value of the shipping passing these points is known.

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS OF MR. W. H. PREECE, F.R.S.

PRESIDENT.

(Concluded from page 99.)

The first cable had guttapercha as a dielectric, and it is still almost exclusively used for submarine cable core; but the manufacture has so improved in the last 20 years that a core having an insulator weighing 150lb. per naut, which then had a dielectric resistance of some 250 megohms a naut at 75deg. F., can now be obtained giving 2,000 megohms at the same temperature. India-rubber is creeping in, owing to the high price and scarcity of guttapercha.

Next to strong tides, rocky bottoms, anchors and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species; but this depredatory worm has been utterly routed by covering the guttapercha core with a lapping of thin brass tape laid on spirally. A remarkable thing about this little insect is that, whereas 20 years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea. A new cable about to connect Scotland and Ireland is being served with brass tape.

With the cables has grown up a fleet of telegraph ships to lay and maintain them. In 1853, the "Monarch," belonging to the Electric Telegraph Company, was the only ship permanently employed as a repairing telegraph ship; now, in 1893, the cable fleet of the world numbers no less than 37, of which seven belong to Government administrations and the rest to private companies, the Eastern Telegraph Company heading the list with five vessels.

Perhaps the most remarkable history of a cable is the following: In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one. A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on. This cable was submerged between that island and St. Bees, where it remained until 1885, when it was replaced by a three-core cable. It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever. The durability of submarine cables is remarkable. That laid between Beachy Head and Dieppe in 1861 is still working, and that laid between Beachy Head and Havre in 1870 has broken within the last month for the first time.

Despite the enormous growth of submarine cables during these 42 years, there would appear to be plenty of scope for still further extension. The Pacific still remains untouched, and a project is at the present time under consideration to connect our possessions in North America with those in Australia.

III.—LIGHTNING PROTECTION.

In 1752 Franklin established the identity of electricity and lightning, and showed how buildings could be protected from the ravages of thunderstorms. This was one of the most beneficent conceptions of scientific practice. The discovery of a cause led to the application of a remedy. Experience has scarcely improved on Franklin's methods. The simple secret was to construct an easy metallic path for the electric charge to flow silently, safely, and imperceptibly to earth, without mechanically rending and tearing the air in one of those long, violent, disruptive, and destructive sparks where energy was suddenly expended in producing heat, explosion, light, and sound. It was prevention, not cure. There is no more perfect apparatus in existence than the lightning protector, and if it ever does fail to do its duty, it fails from man's neglect of some simple rule, or his apathy in maintaining in proper order his uncomplaining slave. Immunity from accident leads to neglect, and neglect breeds danger. Periodic and systematic inspection is the only possible means of preventing decay of effectiveness. In 1892 not one single accident was recorded to any high-class telegraph instrument in the whole of the United Kingdom. Prof. Oliver Lodge has, with characteristic energy, endeavoured to modify our views as to the behaviour of lightning discharges and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience.

IV.—Railway Signalling.

The application of electricity to block signalling is marked by three distinct epochs—its first inception, its popularisation, and its combination with the mechanical signals.

In 1852 the traffic on our railways was regulated by time and sight, and the safety of the railway traveller mainly depended on the watchfulness of the driver. The difficulties which attended the working of the enormous traffic with which the London and North-Western Railway had to cope, during the great exhibition of 1851, induced that company to seek the aid of electricity. It was then that Mr. Edwin Clark, employing for the purpose the double-needle form of telegraph in use, devised what may be regarded as the parent block system, and it became one of my earliest duties to work it out and to apply it. In 1854 the Great Northern adopted it, and it is interesting to note that, although its application was for a considerable period exceedingly limited, in character and principle it remains to-day very much what it was when first established.

In 1861-62 it was my privilege to become still more intimately connected with block signalling, for at that period I developed on the London and South-Western Railway the system which is known by my name. The characteristic of this system is the assimilation of the outdoor to the indoor signals, thus placing in the hands of the signalman a counterpart of the signals worked by him for the guidance of the engine-driver—the same semaphore signals, the same kind of interlocking switches, and the same mode of working. My object was the provision, not only of a reliable system—one which should record its own action—but also one which should popularise block working, and which should in a great measure dispense with that course of instruction which, at that time, formed one of the impediments to its more rapid adoption. Walker and Tyer worked in the same field; while Mr. Spagnoletti sought a similar result by employing, in the place of the indications of the needle, a movable flag inscribed "line clear," "line blocked."

Great as are the advantages of the block system, as it is popularly known, there is yet room for improvement. Over thousands of miles of railway the electrical signals are worked independent of the mechanical signals. It is possible to operate the one without the other. The desirability of welding the two together, so as to render them perfectly homogeneous in their action, was recognised by me as early as 1870, when what I believe to be the first interlocking of the electrical with the mechanical signals was effected at Southampton, and subsequently at Wimbledon and Kew, on the London and South-Western Railway. At this time the transference of the telegraphs to the State called for my services in another direction, and the subject was dropped. In 1875-77 the combination was, however, most effectually completed by Mr. Sykes, who has now brought his system to great perfection. He was followed, in 1877-78, by Saxby and Farmer, under Hodgson's patent; and later still by Mr. Langdon, on the Midland Railway, and by others. It now only remains for the railway companies to apply such of these inventions as may be most suitable to their system, in order to place block working upon a perfectly sound basis.

The latest application in this now extensive industry is Tyer's train tablet system, produced in 1878; together with that of the electrical train staff, devised and elaborated by Messrs. Webb and Thompson, of the London and North-Western Railway, in 1889. Both systems tend towards the modification of the difficulties, as well as the cost, attending the working of single lines of railway.

To railways electricity has proved an invaluable adjunct. In the repetition of signals obscured from the view of the signalman, introduced by me in 1862; of that of the light which forms the night signal, introduced by Warwick about the same date; of telephony, now becoming daily more and more indispensable—electricity plays an unobtrusive part, the value of which is only felt when, from some cause, its use has to be temporarily suspended.

A possible further field for the employment of electricity in railway working may yet be found in automatic signalling. In the United States it has been so employed to a great extent. In England it has, so far, failed to find a footing Here, railway managers appear to be averse to the employment of any system which fails to fix the responsibility of failure which may lead to disaster.

The block system is now, by Act of Parliament, compulsory on all British railways; and that industry, which at its inception worked its way so slowly into use, now controls the traffic which daily passes over 28,000 miles of line, and plays not only an important part in the conduct of railway traffic generally, but proves to be the chief factor in the prevention of accident and the protection of life. Without its aid it would be utterly impossible to deal with the railway traffic of the present day.

The enormous development of electrical engineering upon our railways is shown by the following return from one system only:

Midland Railway Telegraph Plant, Dec. 31, 1892.—Approximate.

S.N. Block instruments	4,350
Block bells	2,645
Signal repeaters	2,500
Light repeaters	640
Message instruments	1,736
Instruments of other kinds	3,108
	14,979
Mileage of wire for block	5,712
,, ,, other purposes*	5,582
	10,294

* Exclusive of P.O. wires.

V.—Telephony.

I had the good fortune in 1877 to bring to England the first pair of practical telephones. They had been given to me in New York by Graham Bell himself. After a series of experiments, I brought them before the British Association meeting, which was held that year at Plymouth. Who at that time could have imagined that the instruments, which were then but toys, would, within 16 years, have become a necessity of commercial, and almost of domestic, life? Yet to-day the number of telephones in actual use may pretty safely be put down at a million!

During 1878 Edison devised his carbon transmitter, and Prof. Hughes presented his "microphone" to the world. These inventions made the telephone a practical instrument of vast commercial importance. It may be said to have sprung into existence well-nigh perfect; and the fewness of the actual improvements on the Bell receiver and the Hughes microphone is scarcely more astonishing than the immense number of fruitless attempts at improvement that have been made. Even now the original instruments are not easily beaten.

The institution of telephone exchanges has led to a development of systems of switching that might fairly be considered a special study in themselves, and the demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits.

It is in this latter field that I have been a diligent worker, and the application of the so-called "K R" law has proved of material benefit in connection with the problems of long-distance telephony. It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity, K, and the resistance, R, of the circuit. It is very much the fashion to deny the accuracy of the K R law. This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law; but it is a law that has determined the dimensions and speed of working of all our long submarine cables; it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out to enable Dublin and Belfast to speak to London—a message of peace to Ireland as solid and substantial as any promised political proposal.

The New York and Chicago trunk line is 950 miles long, and it is built with 435lb. (or No. 8 S.W.G.) copper wire. This wire gives a resistance of 2·06 ohms per mile, which is easily verified; but it is said by Mr. Wetzler to have a capacity of 0·0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0·0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr. Edison discovered this in 1872, when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0·005 microfarad per mile. I should estimate the Chicago circuit at 0 004 microfarad per mile, and the K R at 7,500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600lb. per mile; but if it had been in England I should have used 1,000lb., for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1,200lb. wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit:

Loop *viâ* different routes	120 words per minute
,, on same poles	150 ,, ,,

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at once. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electromagnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables.

I have recently devised a new form of cable which will probably quadruple the rate of telegraph working to America; and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

VI.—Domestic Applications.

The era of the application of electricity to domestic purposes may practically be said to date from about the year 1850, when Hipp, of Neufchatel, introduced into the Berne Chamber of Deputies a system of electric bells. The system was taken up by Breguet, of Paris, and largely introduced by him in France. The system, as arranged by that inventor, was brought to England by me in 1863, and taken up by Messrs. Adams, the well-known firm of ironmongers, of the Haymarket. Although some time elapsed before the system took a firm hold, its subsequent progress was very rapid, and now forms a very flourishing branch of electrical industry.

There can be but little doubt but that the success which electric bells for domestic purposes has attained has been mainly due to the introduction, in 1866, of the Leclanché battery. The perpetual attention which Marié Davy and Daniell cells (the form of batteries at first employed for the purpose) required must have very seriously, if not fatally, hampered the march of the most successful of the domestic applications of electricity, had the invention of the Leclanché battery not come to the rescue.

Fire and burglar alarms, as applied to houses and worked by electric action, to some extent preceded the introduction of the electric bell system, and many exhibits of these appliances were made from time to time; but their success has been very partial, and chiefly, no doubt, because these appliances, being very seldom required for use, get out of repair, and have an unfortunate trick of failing exactly at the time when they are most required.

Water-level apparatus, though perhaps not strictly classifiable with domestic appliances, in so far as they are closely connected with water supply, may be alluded to. In the International Exhibition of 1862 an apparatus of this kind, devised by MM. Mouillon and Vinay, was shown in action; and within the last 15 years the Postal Telegraph Department has fitted and maintained with great success special forms of instruments, designed and worked out by Mr. H. R. Kempe, for various water companies.

Electric clocks have been a very favourite subject for invention, and were introduced in the very early days of the electric telegraph; an enumeration of the patents taken out for these appliances would run to a very long list, but the record, with a few marked exceptions, is practically one of failure, representing much ingenuity but little real utility. We use in several post offices systems of electrically-controlled clocks that work very well.

Electric hoists, devised by Siemens, Hopkinson, Crompton, and others, have been used to some small extent; but their introduction has not been so extensive as might have been anticipated. One cause of this is, no doubt, the want of a good self-starting alternate-current motor; but it is more especially due to the question whether at present high prices electric energy for the purpose can financially compete with the generally adopted means of working the hoists.

For ventilation purposes on a small scale, the adoption of fans for the purpose should prove of considerable value, as such fans can be placed in any convenient place out of sight and be contained in a very small compass.

Heating and cooking apparatus worked by electricity have not at present a very favourable outlook, though many appliances of the kind have been shown in operation, especially at the recent Crystal Palace Exhibition. The question is far more a financial one than anything else, and the public have not yet been educated up to the point of paying heavily for *biftek à la Française* because it is cooked on highly scientific principles. I have in use in my house a flat-iron, a tea-kettle, and a curling-tongs heater, each heated electrically. I must omit not to mention the large use of "electric gaslighters," an invention which has hardly received the full credit which it deserves.

VII.—Electro-chemical Industry.

The electro-chemical industry is, financially, one of the most important in this country. Electroplating was started by Elkington, at Birmingham, in 1840. There are now about 170 electroplaters in Sheffield, and over 100 in Birmingham. Christophle, of Paris, deposits annually six tons of silver.

Nearly the whole of the copper used for conducting purposes in the various applications of electricity is extracted from its impure ores by electro-deposition. 0·3 h.p. continuously applied deposits 1lb. of copper per hour, and this costs about 0·1d., so that the process is very cheap while the effect is wonderful, for copper is now frequently supplied having a resistance of 102 per cent. of pure copper. This is due to the fact that the specific gravity of the material has been raised from 8·90, at which Matthiessen took it in 1862, to 8·95, which is now obtained with hard-drawn electro-deposited material.

Aluminium is being extracted in large quantities from cryolite in England and in the United States (Pittsburg). In Switzerland water power at Neuhausen—the falls of the Rhine—is being very successfully employed for the same purpose. The price of the metal has, in consequence, fallen very much, but the demand is greater than the supply, and the price is rising.

Many attempts have been made to produce caustic soda and chlorine from common salt, especially for bleaching purposes in the paper industry; but all the difficulties in the case have not yet been surmounted, the principal one being the destruction of the anodes—at any rate, the industry is not a staple one at present. An interesting process, by which phosphorus was separated from corundrum, a mineral phosphate, by the dissociating effect of the terrific heat of the electric arc, was developed by Readman, Parker, and Robinson, at Wednesfield, near Wolverhampton; but though the right to use this mode of producing phosphorus was purchased at a very high figure by those who have the monopoly of that business, it does not appear that it has been put to practical use at present. Great advances and developments are being made in other directions, notably in the production of ozone, in electrical bleaching, and in reduction by the electrical furnace.

There are few oxidising and reducing processes in chemical industry which cannot be effected economically and with advantage by the electric current, and the extreme cheapness with which electrical energy can be manufactured when used continuously, and when produced by falling water, as well as the extreme purity of the resulting deposits, are calling earnest attention to this lucrative branch of the business. It is not impossible to produce a kilowatt-hour of electrical energy by means of water power for 0·1d., and when this is stated to be equivalent to gas used for illuminating purposes at 0·6d. per 1,000 cubic feet, it will be seen what a potentiality of wealth there is in this (at present) much-neglected waste energy of Nature.

VIII.—Electric Lighting.

Although the arc lamp was invented very early in the century, and the incandescent lamp made a fitful appearance in 1845, it was not until Jablochkoff startled the world with his candle in 1877, and Edison and Swan perfected the carbon filament of high resistance in 1880-81, that the electric light began to attain its practical stage. Its rapid development has been seriously retarded in England by the operations of a monster called into existence by the limited liability legislation of recent years—the rapacious financial promoter—whose plunder in one year of our period far exceeds in amount the sum of all the thefts of all the highwaymen and burglars that were ever hung. He has ruined the prospects of private enterprise, and has rendered absolutely necessary the Acts of 1882-88, which have thrown the industry into the hands of the local authorities of our cities and boroughs.

The incandescent lamp has been greatly improved, and as this year will witness the expiry of controlling master patent, we shall see the price reduced to something not far from 1s. Some of us can remember the time when the price was 25s. It has now for some time been 3s. 9d. As a incandescent lamp costs only 9½d. to make, we may reasonably hope that my anticipation will be realised.

The cost of wiring is a great deterrent to the introduction of the electric light into small tenements and into houses held on short tenures. The materials used must be of the most perfect kind, otherwise insecurity is incurred; but there are expensive practices of wood casing and of ornamentation which want reform. The Cheap Jack is the curse of the industry, and the absence of specification and of inspection the danger of the user. The fire insurance offices have maintained our practice in England pretty secure, but in other countries the character of the work has been very indifferent.

The problem of economic distribution has been much simplified by the introduction of the three-wire system by Dr. John Hopkinson, and by the improvements made in high-pressure apparatus. High pressure not only economises the heavy cost of mains, but simplifies immensely the mode of regulation. The early pioneer alternate-current systems, which have done so much to further the development of electric lighting, were, however, costly in their coal bills, owing to great losses of energy in their iron and copper, but the transformer of the present day is as perfect in efficiency as the dynamo. These losses have practically disappeared, and modes of switching transformers in and out at will have removed every difference of cost between high-pressure and low-pressure systems. The prejudice against high pressure is still strong, but time and experience will eradicate it as they ultimately eradicate every fallacy. The prejudices against high-pressure steam and against high speed on railways were once equally strong, but those prejudices survive only as "bees in the bonnets" of a few.

The progress in electric lighting is now principally economical. The cost of production of electrical energy is rapidly coming down. Elements of waste are being eliminated, and continuous working throughout the day and night is being encouraged. If a full load could be maintained during the whole 24 hours, electrical energy could be manufactured for one third of a penny per supply unit, and this is equivalent to gas at 2d. per 1,000 cubic feet. The potentiality of economy in electric lighting is thus beyond the dreams of the gasman. The most marked features in the development of this great industry are the ostrich-like blindness of the gas manager, who buries his foresight in his fat dividend, and the childish wailings of gas technical journalists. The gas industry should itself have nursed this herculean infant who is rapidly strangling one of its main sources of profit. Fortunately for the gas shareholder, there are other sources of income—warming, cooking, motive power—to be developed. Our corporations and local authorities are showing more astuteness. Manchester, Nottingham, Dewsbury, though successful gas producers, have assumed also the position of undertakers of electrical energy.

Monopolies are held in pious horror by the critical public, but it fails to draw a distinction between a monopoly held by the few for their own personal benefit at the expense of the many, and that held by the many for their own purposes, comforts, and economies. Electric lighting, carried out under the provisions of the Acts of 1882 and 1888, is a self-supporting, self-managed, and profitable industry. It is a business of a mutually co-operative character, carried on by the ratepayers themselves for their own sole benefit.

The bright illumination of our streets increases their security, not only from crime, but from accident. Accidents in large towns are relatively greater during the hours of darkness than during daylight. The amount of light distributed over the roadway by an ordinary street gas-burner is very small, but arc lamps can be so distributed as to rival daylight in their illumination. If anyone wants to know what can be done in this direction let him visit Spiers and Pond's establishments in Water-lane, Blackfriars.

The rate of growth of the industry is shown by the following returns :

	London.
December 31, 1890	145,000 electric lamps fixed.
" 1891	330,000 " "
" 1892	500,000 " "

	Bradford. (Lamps.)	St. Pancras. (Lamps.)	Brighton. (Lamps.)
1889	1,000	—	—
1890	8,467	—	—
1891	15,000	13,000	2,572
1892	20,000	21,000	10,248

Nothing can stop the growth, or prevent the rapid spread, of this beneficent and sanitary mode of illumination into the confined, ill-ventilated, overcrowded homes of the working population. The electric light is essentially the poor man's lamp.

Many efforts are being made to utilise the waste forces of nature in producing electric currents for the economical supply of the light. In America, Scotland, Switzerland, Italy, and, indeed, wherever waterfalls are available, electric plant is being installed to convert the energy of the fall into the useful form of electricity. At Tivoli, near Rome, a fall of 165ft. is used to work six turbines of 350 h.p. each, giving 2,100 h.p in all. Six high-pressure alternators working in parallel send electrical energy at over 5,000 volts pressure to Porta Pia, near Rome, 14·8 miles from Tivoli, through four stranded copper conductors, each having a diameter of 13mm., and bunched into one metallic loop, giving a total resistance of four ohms. At Porta Pia the 5,000 volts are reduced to 2,000, and the currents are distributed to several sub-stations spread over the city, where they are again lowered to the safe pressure of 102 volts, at which voltage the current is supplied to the consumer on the three-wire system. There are 600 arcs and 30,000 incandescent lamps in use in Rome, but they are not all supplied from Tivoli. I inspected this installation only a few days ago, and found everything working smoothly and efficiently under the able guidance of Prof. Mengarini.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and upkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo, 30 miles away, but it is certain that at Tivoli it can be so applied with advantage and profit.

There is much water power in this country that might be usefully employed. At Worcester it is proposed to use the water of the Teme, a tributary of the Severn, to supply electrical energy to the city—an experiment that will be watched with considerable interest, for the use of water-power will solve the difficulty occasioned by light loads during the small hours and daylight. Keswick and Lynton have already been so served, but on a small scale only.

There are many towns whose public streets could be brilliantly illuminated by the streams running past them, but there is much fear and distrust to be removed from the minds of our local magnates, and a considerable amount of education necessary before the public will receive the full value of the gifts that nature so freely places at its disposal, and the engineer so thoroughly converts into a utilitarian form.

The rippling brook, the rhythm of falling water, the flowing tide, and the stream that rushes wildly over well-worn boulders, have furnished the poets of all ages with imagery and with illustration :

"All nature rejoices
And moves with a musical flow."

But no poetry of the past surpasses the poetry of the modern engineer, who transforms this musical flow into a gentle form of silent energy that answers the first fiat, "Let there be light," and that gives comfort to the home, health to the being, and security to the worker.

IX.—Power Transmission.

The oldest proposal for transmitting power electrically over a distance is probably that contained in the patent specifications of H. Pinkus, who proposed in 1840 to work an electric railway by power obtained from large primary batteries established on the line, but not carried on the trains. Pinkus must have contemplated transmission of current by wire. The first time power transmission was publicly shown was by Fontaine in the summer of 1873 at the Vienna Exhibition ; but whether the discovery of the reversibility of the dynamo and of the possibility of transmitting energy from a generator to a motor through a long length of cable was purely an accident or the outcome of conscious investigations is not known. The story is told of an attendant who, when tidying up the stall of the Gramme Company, saw two cable ends lying loose, and, thinking they belonged to a Gramme dynamo near by, inserted them into its terminals. The machinery immediately began to revolve, and it was then found that the other ends of the pair of cables were attached to another machine which was working. The transmission of power by means of two Gramme dynamos was also shown at the exhibition of scientific apparatus in South Kensington in 1876. Although experiments of this kind were repeated by various scientists, the discovery seems to have been left undeveloped until Messrs. Chretien and Felix applied it, in 1878, on a practical scale for working an elevator, and in 1879 to agricultural work. The generator was a Gramme dynamo at the Lermaise sugar factory, and the energy was used for ploughing a field half a mile away at the rate of 200 square feet per minute, which corresponds to about 8 h.p. in the plough rope. The first electric tramway was that shown by Siemens in 1881 at the Electrical Exhibition in Paris.

Since then the industry has begun to develop, and many electrical engineering firms took up power transmission. In 1882 Mr. Gisbert Kapp discovered that it was possible to get constant speed at the motor under extreme variations of load if the generator and motor were series machines and had characteristic curves which corresponded to each other. He applied the discovery for working the patternmakers' shop at Messrs. Crompton's works at Chelmsford, where the load was, of course, liable to great variations. This principle has since then been used by Brown and others in a number of power plants on the Continent. It is also used for working machine tools, travellers, and other shop appliances, and in Messrs. Denny's shipyards at Dumbarton there is an extensive system of circuits with terminals so placed that work may be done by electric machine tools on any vessel in the yard. In 1886 Mr. Mordey pointed out that a shunt motor regulates for constant speed under varying load if the supply voltage is kept constant. France has very much developed this industry ; in Italy we have magnificent examples in Genoa and Tivoli ; but it is in Switzerland, where water power is so abundant, that it has flourished so well.

Ferraris and Tesla in 1888 discovered, independently, the rotary-field motor worked by multiphase alternating currents. With this discovery the range of transmission has been enormously extended, since much higher voltages than are possible with continuous currents can be employed. Meanwhile, power transmission by single-phase alternating current has also been developed, the earliest example of magnitude being the electric lighting station at Cassel, designed by Oscar von Miller, and started in the beginning of 1891. The Helibronn three-phase transmission, started a year ago, is working most satisfactorily for distribution of light and power. Inventors are, however, busy on single-phase alternating-current motors, so that existing alternating-current stations may distribute power as well as light, and Messrs. Ganz and Co., Messrs Brown and Boveri, and the Oerlikon Works have already produced serviceable motors working by single-phase current. Only a few weeks ago a single-phase current motor was installed at the printing works of a newspaper in Chur and connected with the town mains. The paper is now printed by electric energy brought from a waterfall several miles away. The use of electrically-transmitted power in mines has greatly increased during the last few years, especially in America. In Ireland, the falls of Bushmills work the electric tramway from Portrush to the Giant's Causeway, and those of Bessbrook the line from Newry to Bessbrook.

We are anticipating considerable developments in this direction in Niagara, but nothing electrical has yet been done there. It is a subject of congratulation, however, to this country, and especially to this Institution, that one of its members of council—Prof. George Forbes—has been appointed the engineer to carry out the electrical work. We may probably see power transmission developed by alternating currents in this district on a scale beyond the dreams of science, and voltages of from 5,000 to 10,000 volts handled with ease and safety.

X.—Electric Traction.

The use of electrical energy for working railways is making gigantic progress in the United States, and has commenced to make a serious move in the United Kingdom. The City and South London Electric Railway has proved a decided success, and next week will record the opening of a still larger enterprise on the elevated railway of the Mersey Docks in Liverpool. When last I visited America, in 1884, there was only one electric railway in work, and that was in Cleveland. One company alone, the General Electric Company of the United States, working the Thomson-Houston and Edison systems, has now—

Roads in operation and under contract	440
Cars	8,856
Miles of line in operation	4,628

Thus the average length of electric railway is 10 5 miles, and the average number of motor cars in use about two per mile. The power used is over 100,000 h.p. Speeds of 40 miles an hour are sometimes obtained in the open country, but in the crowded streets this rate is much reduced.

In 1892 there were 250,000,000 passengers carried, 50,000,000 car miles run. The capital invested in such railways is £12,000,000, and the cost of working comes out at 6d. per car mile. All these railways are worked with overhead conductors, by what are known as trolley lines. Such a line is at work in Leeds, and the South Staffordshire Tramways have just started the same practice.

Considerable experiments have been made to work tramcars by accumulators carried on the car. They have not met with much success, owing to the cost of renewals. The Birmingham Central Tramways are, however, persevering in this direction, and they are now giving an extensive trial to a new form of accumulator—the Epstein—the proprietors of which have adopted the novel plan of undertaking to renew the accumulators at the rate of 1½d. per car mile.

XI.—Theory.

In the presidential address which I delivered to the Society of Telegraph-Engineers and Electricians in 1880, I took the opportunity to formulate the theoretical views of electricity that I had acquired at the feet of Faraday. It is not given to every boy to have his great ambitions realised. One of my ambitions as an earnest listener to Faraday's simple and delightful lectures was to be his assistant, and in almost the last investigation he undertook on electric induction in underground wires, it was my privilege to see much of him, and to prepare many experiments for him.

Early in 1854, at his wish, I carried out for Mr. Latimer Clark certain experiments on the comparative effect of increments of voltage in increasing the rate of transmission of signals through long telegraph circuits. It was found that variation of voltage had no effect. Currents from 31 and 500 cells sent through 768 miles of guttapercha-covered underground wire showed precisely the same velocity. These experiments were sent by Faraday to Melloni, who had prompted the wish, and Melloni ("Faraday's Researches," vol. iii., p. 577) remarked: "The equal velocity of currents of various tensions offers a fine argument in favour of the opinion of those who suppose the electric current to be analogous to the vibrations of air under the action of sonorous bodies." This is to be found in the very last contribution inserted in the greatest work ever published on our science, "Faraday's Experimental Researches in Electricity."

Faraday's views were subsequently expounded and extended by Maxwell, who said: "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematician saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids" (Maxwell, "Electricity," vol. i., p. 10).

Since that period I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space; and during my long apprenticeship of 40 years I have never examined one experiment or considered one fact that was not explicable on this theory.

It must be distinctly understood that I apply the term electricity to that form of energy which we as engineers utilise in the service of man. I do not apply it, as some physicists do, to a mere imaginary factor of this energy, sometimes called "quantity," and even honoured with a unit—the coulomb. I use it in the same sense that we use the terms light, heat, and sound, which are universally acknowledged to be forms of energy. In my address as president of the Mechanical Section of the British Association at Bath in 1888, I pointed out the great confusion that arose from this misapplication of terms, and I suggested that the disturbing factor—the vague subjective unreality of the physicist—might be called by some other term. I now go further, and suggest that the term be abolished altogether. We can do without it. It is not wanted. We have excluded the coulomb from our new legal system of C.G.S. units.

The electricity of the engineer is a definite form of energy. It has one objective reality that we can generate, utilise, measure, and sell. It is even regulated by Act of Parliament. It is, moreover, "understanded of the people."

The tendency of modern practice is to import simplicity into theoretical enquiries. True theory does not require the abstruse language of mathematics to make it clear and to render it acceptable. The doctrine of evolution, the principle of the conservation of energy, the undulatory theory of light, the thermal equivalence of work, the development of electro-chemical transformation, and all that is solid and subtantial in science and usefully applied in practice, have been made clear by relegating mathematical symbols to their proper store place—the study.

The doctrine of the conservation of energy implies that energy, like matter, cannot be created or destroyed. Its form only can be changed. Its total value always remains the same, and we can always measure it when all the different forms in which it exists in the particular system are taken into consideration. There has been no more fruitful principle introduced into science during this century than the equation of energy, which implies that the total energy of every physical system is the sum of all the energies of its different parts, whether usefully or uselessly expended.

Maxwell said: "The special work which lies before the physical enquirer is the determination of the quantity of energy which enters or leaves a material system during the passage of the system from its standard state to any other definite state."

Every molecule at any instant of time is in one place only, and any change of its position during any interval of time is the result of force applied, and is effected along a continuous path and in an orderly manner. The laws governing the mode of motion, and determining the direction, magnitude, and nature of the work done, are the objects of physical research.

The molecular theory of electricity, which regards it as a form of energy, supplies the physicist with a powerful weapon to combine in one great science of "energetics" all physical phenomena. Maxwell, had he lived, would probably have accomplished this. He raised a superstructure upon the foundation-stones laid by Faraday. He annihilated action at a distance, he established the existence of stresses and strains in the ether, and he showed the identity of luminous and electromagnetic waves. Subsequent experiments have confirmed his views.

Electricity is therefore energy which is transmitted by matter and through space by certain disturbances the result and the equivalent of work done, and in certain orderly and law-regulated forms, called "electromagnetic waves." It is not difficult to conceive the ether carved or the molecules of matter swayed or excited in definite periodic waves. A molecule is subject to all kinds of motion—translation, oscillation, rotation upon its own axis, and revolution about some external axis. Clausius (*Pogg. Ann.*, clvi., p. 618) suggested that the atoms or groups of atoms constituting a molecule revolve around one another similarly to planets, and are sometimes nearer to and sometimes further from each other. The difference between the infinitely great and the infinitely little is only one of degree. The motions of the solar system and that of a molecule of water are similar. These motions are imparted to and transmitted by the ether, and they are taken up again by matter. One kind of wave gives us light, another radiant heat, another magnetism, and another electrification. The rate at which these waves move is the same—viz., 30,000,000,000 centimetres, or 192,000 miles, per second. It is only their form and their frequency that differ. Matter and ether are subject to strains, currents, vortices, and undulations, and every single electromagnetic phenomenon can be compounded of or reduced to one or other of these mechanical disturbances. Rotation in one direction gives positive electrification; rotation in the opposite direction gives negative electrification. A whirl in one direction gives us north magnetism; in another direction, south magnetism. Hertz, the experimental exponent of Maxwell's views, has shown the existence of electromagnetic waves, and has proved their reflection, refraction, and interference. The rate of their propagation is the same in ether, air, and conducting wires.

The most recent discoveries and deductions are all in accordance with this mechanical theory. J. J. Thomson's views that at high temperatures, in the act of dissociation, all gases, and Dewar and Fleming's conclusion that at low temperatures—in fact, at the absolute zero of temperature—all metals become perfect conductors, might almost have been predicted. Hysteresis and Foucault losses are mere wastes of energy, due to molecular friction or to internal work done on the molecules, assisted by bad design and impure material; but, being measurable and comprehensible, their reduction to a minimum has become possible and actual.

It is a misfortune that a beautiful hypothesis like Maxwell's electromagnetic theory of light has been discussed almost solely by mathematicians. Its consideration has been confined to a small and exclusive class. It has not reached the public, and this is to be regretted, for, after all, it is the many and not the few that determine the acceptance or refusal of a theory. The existence of the ether is now thoroughly comprehensible. Light is now regarded as an electromagnetic disturbance. The eye is an extremely sensitive and delicate electromagnetic instrument. The difference between luminous, thermic, and electromagnetic waves is one of frequency and form. We thus have to consider the propagation of these waves not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction. The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electromagnetic wave, and why the transversal disturbances are secondary waves of electromagnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction. Induction is thus mere transformation of energy whose direction and magnitude are easily calculated.

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holme, a distance of 3·1 miles. The electromagnetic disturbances were excited by primary alternating currents in a copper wire, 1,237 yards long, erected on poles along the top of the cliff on the mainland. The radiant electromagnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island. The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects from conduction; the elimination of mere earth currents from electromagnetic disturbances in air, will form the subject of a separate paper, for their proper consideration would be too tedious for an address. I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory—viz., the practical development and verification of a conclusion predicted from mere theoretical consideration.

The oscillatory character of the discharge of a Leyden jar, which was discovered by Henry in 1842, is an admirable proof of this molecular theory. If two jars, precisely similar as regards capacity and circuit inertia, be placed near each other with their planes parallel, and one of them is charged and discharged, the other responds sympathetically, as do two similarly pitched tuning-forks when one is excited. Prof. Oliver Lodge, who has made this field his own, has shown that by varying the capacity of the jars and the inertia of the circuit, oscillations can be produced to give any required rate of oscillation from one to 300,000,000 per second.

In a room or theatre, when these discharges are excited, it is a common thing to see sympathetic sparks upon the spangled walls, and among the metallic objects scattered about. The whole place is an electric field, which is violently disturbed at every spark, and everything which is "syntonised," as Oliver Lodge calls it, to the main discharge, responds in this way.

It is impossible to account for these effects, which are all cases of transformed kinetic energy, except on the mechanical theory which I have advanced. We have a source of disturbance, we have energy transmitted in waves, we have waves transformed into disturbance again. Energy passes through its various stages by the motion of matter and the action of the ether. Everything is accounted for and nothing is lost. Waste energy only means energy in the wrong place.

The advance of our knowledge in this branch of electrical development has been very much retarded by the phantasies of visionary mathematicians who monopolise the columns of our technical literature and fill the mind of the student with false conclusions. I have no sympathy with the pure mathematician who scorns the practical man, scoffs at his experience, directs the universe from his couch, and invents laws to suit his fads. The American, in his quaint, humorous way, said, "Theory without practice is absolutely a worthless commodity; practice without theory is worth about 15dol. a week; but when both are well combined in one man of sound judgment, the combination is worth up to 10,000dol. a year."

My sympathies are with the earnest worker who asks Nature direct questions by sheer experimental prodding, who elicits from her stronghold the secrets of her prison-house, who presents gratuitously to the world the efforts of his labours in plain language, and who is willing modestly to follow in the footsteps of his great masters—Faraday, Maxwell, Kelvin, Von Helmholtz, and Rayleigh. Such men are to be found on both sides of the Atlantic. Our own *Proceedings* chronicle the work of Hertz, Tesla, and Elihu Thomson.

I must not exclude the teacher, the much-abused professor, who combines practice with theory, and who, in our technical institutions, is training up a body of youths destined to carry on the great work of the future. Amongst these able men there is no one who has earned a more richly-deserved reputation than my predecessor in this chair (Prof. Ayrton).

XII.—Conclusion.

Although my practical experience extends over 40 years, my personal reminiscences commence with the reign of the Queen, and are therefore coincident with the Victorian era. When we look around us and think of what we have now, it is well to think sometimes of what we had not in days gone by. I was bred in a Welsh seaport town which had no gas, there was not a steam-engine in the place, the mails came from London by coach, there was no railway in the country, photography was unknown, there was no daily paper, but an indifferent weekly journal was slightly supported. A letter to London cost 1s. The flint and steel and tinder-box were still in use, and the lucifer came one day as a wonder and a surprise. Artificial illumination was obtained amongst the lower classes from the rushlight and the tallow dip. The moulded candle came as a luxury to the upper classes. Snuffers were in use, and an oil lamp was a curiosity. Think of the luxuries we have now: of what science, and especially electricity, is daily doing for us. Progress is advancing with such rapid strides that, when the time comes for my son to chronicle to some institution of ethereal engineers his experience of 50 years' observation, the people of his day may look back with pity and amusement at the backwardness of the times of 1893. Even this address may be quoted as an illustration of the ignorance of the great Victorian period.

Cannot the electrical engineer claim some share in the progress of the world? Has he not robbed the thunder of its terror? Has he not annihilated space, bridged the ocean, and brought the Antipodes within the same fold as home? Has he not sent lightnings from heaven, so that they go and say unto us, "Here we are"? And are not all nations of the earth more amenable to reason and less subject to passion when they are brought within speaking distance of each other? Is it nothing to have brought health and comfort and cheerfulness into the house and security into the street? Is it not something to have rendered a first-class railway carriage, flying at the rate of 70 miles an hour, as safe as one's bed? He has probed the deep, unfathomed caves of ocean. He has extracted the precious metals from their stony bed. He warns us of approaching storms, and brings to our very hearths the tamed energy of the roaring torrent. Commerce, civilisation, politics, and life have all been benefited by his skill and invention, and history cannot fail to record the names of those, among whom are many members of this Institution, who, in this great Victorian era, have done so much to discharge one of the highest duties of man, the fulfilment of the functions of the true engineer.

PHYSICAL SCIENCE IN INDIA.

Sir Chas. Elliott has given the handsome donation of Rs. 5,000, says the *Indian Engineer*, for the encouragament of original research in physical science in Bengal. The interest on this sum is to be awarded annually for the best original essay composed and published during the year describing the results of original research or investigation in any branch of physical, chemical, mathematical, or natural science. It will be called the "Elliott Prize for Scientific Research." Any native of Bengal, or any Eurasian or domiciled European residing in the province will be eligible to compete. The trustees will be the President of the Asiatic Society, the Vice-Chancellor of the Calcutta University, and the Director of Public Instruction, Bengal.

Paris.—Out of 85,000 houses in Paris 20,000 only are lighted by in 1891 the sale of gas amounted to 283,000,000 cubic metres. otal number of incandescent lamps now in use is given at

COMPANIES' MEETINGS.

ELMORE'S FRENCH COPPER DEPOSITING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel, under the presidency of Major Charles Jones, R.A.

The **Chairman** said that in April last it was decided, on the recommendation of the Board, to increase the nominal capital of the Company by the creation of 100,000 preference shares of £2 each. Power was taken to issue 60,000 of these shares so as to raise £120,000 additional working capital, which was considered necessary to meet the liabilities of the Company, and to enable the management to push the manufacture on the large scale for which their works at Dives had been erected. Had that capital been fully subscribed, they would have proved months ago, not only that the Elmore process was a commercial success, but also that it was a financial success. Unfortunately, through various causes, confidence in the Elmore affairs had been shaken, and consequently their preference issue was not responded to sufficiently to enable the Directors to carry out the programme which they had sketched out. As their appeal for further subscription of the preference capital was inadequately responded to, they had not been able to maintain the output at the factory on the scale reached in October last (a scale which would have paid all expenses and left a profit), not having money to purchase sufficient supplies of copper, and not being able to see their way sufficiently far ahead to justify them in taking large orders for forward delivery, and consequently such orders had been reluctantly refused. In November the Directors informed the shareholders that they had made a contract with substantial persons for placing the £50,000 first mortgage debentures then proposed to be issued. Unfortunately they were misled, and these persons had failed to carry out their agreement, thus placing the Company in a position of great difficulty. The money they required had not been forthcoming, and they were about to ask the shareholders to sanction an increase in their borrowing powers, so as to carry out another scheme which had been suggested to them for raising additional working capital. After pointing out what were the capabilities of the Company's magnificent plant at Dives, the Chairman went on to say that they must either raise more capital by some such scheme as they were going to submit, they must sell the Company outright, or they must reconstruct. To raise this money and to provide for their accrued liabilities in England, the following scheme had been proposed: That they should issue 6 per cent. first mortgage debenture stock to the amount of £100,000, redeemable in five years at £105. That the holders of the existing £50,000 first mortgage debenture stock should exchange their stock either for preference shares or new debenture stock. That their English creditors, nearly all of whom were very friendly and ready to help the Company, should take preference shares, as far as possible, in payment of their debts, and that the remainder of the new debentures should be taken up by the present shareholders of the Company for cash, thus providing the additional capital required. It was only by some sacrifice on the part of all concerned that they could hope to save the ship, and obviate, if not the loss of everything, a serious loss all round. A large part of the present debenture stock holders had already consented to exchange their stock for preference shares, and those at a meeting recently held approved of the scheme. The Chairman concluded by moving "That the Directors be empowered to borrow, for the purposes of the Company's business, a total amount not exceeding at any time the subscribed capital of the Company."

Sir James Mackenzie seconded the resolution.

M. Secretan, after dealing with the present position of affairs, said that if the Company were not able to find the necessary funds promised from the beginning the works would be condemned to inactivity, and other people with more confidence would make a fortune on their ruins. If, on the contrary, their help were forthcoming, this was what they could expect: With £30,000 paid over to Paris they would be able in a very short time to produce and sell 75 tons per month, which would give a profit of £11,550 per annum; with £40,000 they could make a profit of £23,400; with £50,000 a profit of £35,250, or with £60,000 a profit of £58,950.

After considerable discussion the resolution was agreed to, and the **Chairman** announced that unless the Board were able to carry the scheme through the Company would be lost.

CITY AND SOUTH LONDON RAILWAY COMPANY, LIMITED.

On Wednesday, Mr. Charles Grey Mott (the chairman) presided at the seventeenth ordinary general meeting of the above Company, held at Winchester House, E.C. The Secretary (Mr. W. F. Knight) having read the notice convening the meeting, and the report being taken as read,

The **Chairman** moved the adoption of the report and accounts. Although they would have been glad if they had had a larger accession of traffic during the past year, and had been able to pay a better dividend, yet on the whole he thought they would agree with him that the report showed very decided progress, and that the condition of the line altogether was satisfactory. During the past half-year they had carried, including an estimate for the season-ticket holders, 600,000 more passengers than in the same period of the previous year. Since the opening of the line down to the present they had conveyed over 12,000,000 passengers, and had carried them safely and without any accident of any consequence. They knew well that during the early part of their experience, he had had year after year to deplore that there were so many difficulties in working, and that their traffic had thereby suffered. It was, however, satisfactory to feel that during the last half-year they had practically had no stoppages of that kind. He did not think there was a railway anywhere which could give better experience of absolute working both as regarded punctuality and regularity and convenience than could be afforded by their line. And considering that that was the first electric railway, and that it had only been in operation for two years, it augured well for the future of similar undertakings. He thought they had done fairly well during the half-year. The Company had considerably improved its position financially. A year ago they had a large amount of Lloyd's bonds and a considerable amount of debts, which pressed heavily upon the minds of the Chairman and Board He was happy to say that those amounts had been very largely reduced, and since the accounts were published they had been able to pay off every debt that they owed, and they had funds in hand sufficient, if necessary, to pay off every one of the terminable debentures, which would come due in the next nine months. Therefore their position financially was exceedingly strong. Turning to the capital account, they would see that during the past half-year they had issued preference shares to the amount of £18,650, and they had expended £4,456 out of that on capital account. They had paid off £6,000 of debentures, and they had reduced their debts by £8,000, which accounted for the £18,000 raised on the other side. Since the accounts were prepared they had issued some further amounts of preference stock, and they had issued all they intended to do for some time to come. As regarded the question of debentures, in order to give the existing debenture-holders every reasonable opportunity, the Directors had offered to them that they should convert their present debentures into the permanent 4 per cent. debenture stock at par, or if they preferred it, that they should receive in exchange 5 per cent. preference stock, also at par. About one quarter of the amount of the debenture debt was so converted, but the other three-quarters had not, and would have to be paid off or dealt with from time to time in coming years. Those who took advantage of the offer made by the Directors were very wise. Their debenture capital had risen to a considerable premium, and he had no doubt that it would go much higher, as it was perhaps as safe and secure a stock to be had. Fortunately, as they could issue that debenture stock from time to time, they would be able so far to reduce the amount of their debenture interest, and he anticipated that in future they would be in a position to make each half-year a considerable additional saving in interest. Now, as far as the revenue was concerned, their receipts from passengers in the six months had been £21,462, as against £19,550 in the same period of 1891. Their season-tickets had yielded £540, as compared with £249; and parcels and other small receipts, £15 as against £5. The parcel traffic was slowly augmenting, and the Directors had under consideration whether they could not considerably develop it. Their transfer fees were £9 against £4; rents, £562 against £435; sundry receipts, £63 against nil. This made a total for the half-year of £22,652, or an increase of £2,409. Well, they knew that in most railways an increase in the gross traffic did not imply a net increase, because it was often absorbed by working expenses. He was glad to say that that was not the case with them. The expenditure for maintenance had been decreased by £101; their locomotive expenditure had augmented by £148; carriage repairs increased by £51; traffic expenses had diminished by £317; general expenses were £110 greater; law charges were £8 more; whilst the rates and taxes remained the same. The result was a net decrease of £127 as compared with the corresponding half of last year. Well, the total result of the half-year was that they had made a profit of £7,262, as against £4,727 in the corresponding period of 1891. That, added to the balance brought forward and bankers' interest, amounted to £8,304, of which the debentures absorbed £4,259, leaving £4,045 available for dividend. That would pay 5 per cent. on the preference shares, and ⅝ per cent. on the ordinary stock, £822 being carried forward to the next account. So far as the present half-year was concerned, he was happy to say that the working showed a most satisfactorily increased traffic; an average increase of £150 a week had taken place since January 1, and if that traffic continued, he hoped that when they next met they would have a more satisfactory dividend to declare than on that occasion. Now they would doubtless be interested to see how far the electric working promised to be really successful and economical. They had had four half-years' working, and could form some kind of comparison and see how they stood In the first half their locomotive expenses—that is, all the expenses which were now comprised under the expenditure of an ordinary steam railway—were 9d. per train mile; in the second half year they were reduced to 7·9d.; in the third, to 7·7d.; and last half-year to 7·1d. Now, in order to make a fair comparison with the locomotive expenses on steam railways, such as the Midland and the London and North-Western, they must recollect that the latter take the price of coal at the pit's mouth and have no carriage to pay. On the other hand, the City and South London line had to pay the carriage from the pit to London, and a further sum for cartage to their depôt; but if they took the price at the pit, their locomotive expenses would be 5¾d. per train mile. On a steam line the rate was rarely lower than 9d., except under special circumstances, and it generally ranged from 9d. upwards. Of course, their trains were not of such carrying capacity as an ordinary railway, but they had run in the half-year, roughly, about 70,000 trains, and they had averaged, including season-ticket holders, about 48 passengers in each train. The first half-year the average was 45, the second 46, the third 47, and the fourth, 48 passengers per train. That was a curious thing; but they must remember that that average was considerably less than half the capacity of their trains, and, therefore, however large their trains were, they would not gain by the size of the trains. Therefore when he said that their expenses were reduced, as he stated they would be on the same comparison of 5¾d., they actually did as much work as if they had a much larger and a more extensive train which was only one-quarter full. Now the total percentage of working expenses was 79 per cent of their receipts in the first half-year, 76 per cent. in the second, 70 per cent. in the third, and 67·9 per cent. in the fourth or last half-year. They would therefore see that the expenses were being reduced steadily and satisfactorily. Then, again, if they wished to compare their percentage of receipts with the ordinary railway, they must take away out of their expenditure the expenses connected with the lifts, which formed no part in an ordinary railway. If they did that, they would find that their expenses amounted to only 59½ per cent. of the receipts, which was very nearly the same as the percentage of the large railways. Some of the lines were a little less than that, but the City and South London line was rapidly coming down, and he hoped as the traffic increased there would be a considerable diminution in that item. During the past half-year they had run in the busy times an additional train service, which had involved an average of 1,000 miles a week, and therefore their train mileage had considerably increased. Of course, they were giving more accommodation. The result was that their receipts per train mile were 2s. 0½d., against 2s. 1d. in the corresponding half-year, whilst in the previous half-year they were 2s. 2½d. Thus they were 2d. per train mile less, but that was an inevitable consequence when additional trains were put on. On the other hand, their expenses per train mile were 1s. 9¼d. in the first half-year, 1s. 7¾d. in the second, 1s. 7¼d. in the third, and 1s. 5¼d. last half-year. Thus, their expenses per train mile were diminishing. The shareholders had some time ago authorised the Directors to convert their ordinary share capital into stock. They had availed themselves of the power, and during the past year they had converted the 600,000 shares into consolidated ordinary stock, and that conversion had already been largely carried out. There now remained some 3,000 shares, and they proposed to ask the shareholders to convert those into consolidated stock, so that the whole of the share capital of the Company would be in the form of stock. It would be much more convenient for every purpose. The only other point was the position of their parliamentary business. They would remember that the Bill of last session, owing to the dissolution, could not be proceeded with, and it was carried over to the present Parliament. It would now take its course from the point at which it left off, so that much additional expense by the transference would not be incurred. He hoped that the Bill would pass, because the rapid increase in their traffic would, he feared, tax the energies and means which they had before they could get any relief under that Act. With regard to the Clapham extension, they intended to carry out a small portion of that to give relief in sidings at Stockwell. They believed it would produce excellent traffic, but it was of no use proceeding with that until they had some means of dealing with the City traffic, and it would be useless to complete that line at the present moment. They thought, therefore, it would be better to leave the Bill in abeyance for the present, and they had launched a small Bill to give them an extension of time, so that they might know what work they would carry out with the Islington extension. They had met with considerable opposition from the local vestry in regard to the Stockwell sidings as to the position for the temporary shaft, but they intended to proceed with the work, and had already sealed a contract for the carrying out of the work without further delay. He then moved the adoption of the report and accounts.

Mr. Sampson Hanbury seconded the motion.

A **Shareholder** then asked what was the amount of the increase in the receipts during the present year, and was informed by the Chairman that for the four weeks the augmentation amounted to £625.

Mr. Drake, who had on several occasions severely criticised the policy of the Board, thought the time had come when they might congratulate themselves. He considered that the horizon was now clear, and that the Chairman was going to come out triumphantly after all. Although only a small dividend, it gave promise of better results in the future. He admitted that he had been in the wrong, and that the Board was in the right, and he thought that the Board should "have its head" like a racehorse.

Mr. Middleton characterised the dividend of ⅝ per cent. as a beggarly return for the money invested in the Company. He thought there were ways and means of improving the returns. The traffic was capable of further development, and the attention of the Board and their staff should be directed more particularly to extending that traffic. He contended that thousands of pounds had been expended upon plant and rolling-stock which was lying idle at Stockwell. There was the fact before them, that whilst they had increased the train mileage, they had decreased the receipts per train mile. Nevertheless their thanks were due to the manager and the chief engineer for their efficiency in dealing with the traffic and general working. He was of opinion that the Directors should modify their fees, and that the efforts of all should be put towards perfecting the undertaking without extending their wings to Islington or anywhere else.

The **Chairman**, in reply, expressed his thanks to Mr. Drake for his kind remarks. With regard to Mr. Middleton's statements, he had no doubt that in the future the increased train mileage would bring in augmented receipts, but it was useless to put on still further trains, as that would reduce the receipts and dividends. They had not reduced their fares, as Mr. Middleton seemed to think, but had increased them. The average receipts per passenger this time last year were 1·70d., now they were 1·64d. per passenger. It was very clear what had arisen. They were encouraging middle day traffic, and would derive benefit from it. He differed with Mr. Middleton on the subject of directors' fees. They formed a large percentage in the early history of every railway, but that diminished year by year.

The motion was then put and was carried unanimously.

Messrs. C. Seymour-Grenfell and H. Tate, the retiring directors, were re-elected, as were also the auditors, Messrs. Turquand, Youngs, Weise, Bishop, and Clark, and Mr. J. L. Oliver.

A special meeting was then held, when the following resolution was passed: "That the existing issued ordinary stocks be, and are hereby, converted into consolidated ordinary stock."

PORTRUSH ELECTRIC RAILWAY.

The seventeenth half-yearly meeting of the Directors and shareholders of the Portrush, Giant's Causeway, and Bush Valley Railway and Tramway Company was held in the Company's offices, Portrush, last Saturday. Dr. Anthony Traill, J.P., F.T.C.D., chairman, presided. The report was unanimously adopted as follows: "Your Directors beg to submit for the approval of the shareholders their annual report to December 31, 1872, which completes the tenth year since the line was opened for traffic. Your Directors have to report a diminution in the receipts under every head during the past year as compared with those of the year 1891, though the total is still in excess of that of the year 1890. In the passenger traffic there has been a falling off in the numbers to the extent of 1,591 first-class and 5,137 third-class passengers, making a total of 84,970, compared with 91,698 in 1891 and 82,802 in 1890. The receipts have consequently fallen to £2,663 ,0s. 5d. as compared with £2,830. 4s. 2d. in 1891 and £2,579. 19s. 5d. in 1890. The goods and mineral traffic fell to 36 tons, from 181 tons in 1891, and 316 tons in 1890, while the receipts under this head have fallen from £29. 1s. 5d. to £17. 7s. during the year. As this traffic was a serious cause of loss in past years this diminution is not to be regretted. The miscellaneous receipts and those for parcels have diminished from £31. 0s. 9d. to £24. 8s. 6d., so that the total receipts from revenue account have been £2,704. 15s. 11d., as against £2,895. 14s. 7d. in 1891, and £2,698. 15s. 4d. in 1890. On the other hand, there has been a considerable reduction on the expenditure side of the account, which shows a total of £1,720. 18s. 10d., as against £1,945. 6s. 6d. in 1891, and £1,687. 12s. in 1890. There is, consequently, a credit balance on the result of the year's working of £983. 17s. 1d., as against £950. 8s. 1d. in 1891, and £1,011. 3s. 4d. in 1890. The past year has therefore fully maintained the successful turn in the state of the finances of the Company which took place in 1890 and 1891, the corresponding credit in 1889 having been only £381. 18s. 7d. It will be seen on an examination of the above figures, that the ratio of expenses to receipts has been 63½ per cent. during the past year, while that ratio was 67 per cent. in 1891, 62 per cent. in 1890, and 82 per cent. in 1889, while the number of miles run by steam power during the year has only been reduced from 12,280 to 12,002, the cost remaining at 1s. per mile. Those run by electrical power have fallen from 19,863 to 14,007, raising the cost from 4d. to 5d. per mile. This diminution of 6,134 in the total number of miles run corresponds with the diminution of 6,728 in the number of passengers carried during the year, but the cheapness of electricity as a locomotive power is still strikingly illustrated by the above figures. Your Directors regret to have to report that during the past year an action for compensation was brought against the Company for injuries caused in the year 1891 to a lady who threw herself off one of the cars, through fright at a collision which seemed to be impending between a steam engine and an electric car coming in opposite directions on the line, though no collision beyond the slightest contact actually occurred. Juries seem to think that companies have unlimited resources, and that they must be in fault, no matter how careless passengers may be, and consequently a verdict was given at Londonderry against the Company for £375 with costs, amounting altogether to about £500. This sum your Directors have been absolutely unable to pay, as the prior charges for interest on money borrowed for the construction and equipment of the line practically consume the balance from the year's revenue account, which accumulated to over £1,600 in the first eight years of the existence of the Company, have only been reduced to £1,579. 12s. 9d. in 1890, £1,569. 2s. 8d. in 1891, and finally to £1,518. 9s. 5d. during the past year. In the meantime, however, the property of the Company is protected by the bill of sale to the Board of Works, which has been renewed every five years since the original loan of £10,000 was advanced to the Company. In conclusion, your Directors have often had to remark in previous reports how much the success of the line depends on the general state of the country, prosperity being accompanied by a rise and depression by a fall in the receipts. The slight fall in the receipts during the past year has, however, arisen from a single anomalous cause, which, fortunately, does not recur save at intervals. The general election seriously interfered with the passenger traffic in the end of June and in the beginning of July, not only in the way of tourists and travellers to the Giant's Causeway, but in the way of summer residents in Portrush, who largely patronise the line during the period of their stay. Many families throughout the country postponed leaving home and making their arrangements for the summer until after the general election, and the loss in the receipts of the Company took place almost entirely during that period, which, in general, is one of considerable value to the Company. From the reduction, however, which your Directors were enabled to make in the working expenses, this loss has been more than counterbalanced, and the net result of the year has, on the whole, been satisfactory, though no dividend can yet be announced. Mr. James Stewart-Moore is the director who retired by rotation, and he is eligible for re-election."

Mr. James Stewart-Moore was unanimously re-elected a director of the Company.

A vote of thanks was cordially passed to the Chairman and the other Directors for their attention to the interests of the Company during the half-year.

The **Chairman** having acknowledged the compliment, the proceedings terminated.

EASTERN TELEGRAPH COMPANY.

The forty-first half-yearly meeting of this Company was held on the 26th ult., at Winchester House.

Sir Jno. Pender, who presided, in moving the adoption of the report, stated that the gross revenue amounted to £352,391, as against £354,939 in the corresponding year, or a decrease of £2,548 Analysing the message receipts, he said it was found that the decrease in the tariff in certain places would be recouped by the increased prices in other places. The total working expenses for the half-year amounted to £98,787, as against £97,131, or an increase of £1,666; and out of that sum they had written off £1,754 more for depreciation of cables. There had been a decrease of £9,000 in the repairs, and, in addition to keeping their own cables in order, they had been doing work for three other companies, and by that and other means they were enabled to carry forward £62,847, as against £57,509, or an increase of £5,338. That he thought to be a satisfactory statement, and he mentioned that their ships which were employed in repairs had earned about £15,000 in the half-year. During the past month they had had to make many repairs; but experience had taught them how to deal with those repairs, and more and more to establish their cable system as a property. Speaking of Egypt, he said it was one of their best stations, for they had a very important traffic with Egypt. He did not believe there was a better-governed country in the world at the present time under English rule. Men of experience had been placed there who were working with an unselfish motive; the only selfishness being that they wished to command the respect and gratitude of Egypt to their just and wise government. The present trouble was insignificant, and he had no fear of any serious complication arising. The reason why he alluded to this subject was because the better the country was governed the greater would be the traffic over their system to Egypt. Referring to the scheme for a telegraph from Africa to Egypt, he said endeavours were being made to open up Africa, and Mr. Rhodes proposed eventually to carry through Africa to Cairo a telegraph system which he (Mr. Rhodes) thought would one day enable him to carry telegrams from the Cape to Europe for something like 2s. 6d., as against 9s. 6d. at the present time. By the time Mr. Rhodes got to Wady Halfa this Company would have a capital much larger, probably, than that which Mr. Rhodes proposed to have to carry his telegraphs through Africa. But, in the meantime, every step that he took, or every territory he passed through, depended upon his finding gold. When it did reach Cairo, this Company would be very willing to meet Mr. Rhodes upon his own ground, and he thought the chances were that, looking to the greater security which existed in submarine systems against land lines, this Company would be able to do the work more cheaply than Mr. Rhodes could possibly do. Sir John, however, wished that gentleman all success in opening up the Dark Continent. So far from any competition arising in that direction, there were few present who would live to see it. Continuing, Sir John said that they had just settled with the Eastern Extension Company a slight increase in the rates to Australia. The reduction that took place was a very serious one—from about 10s. to 4s.—and the guaranteeing Governments found that the recouping had not taken place so rapidly as they anticipated, and when they asked for a rise of 9d. this Company did not oppose it. Their property was increasing in value, and was likely to become more so. Since the last meeting a contract had been made to lay a cable to Zanzibar to Seychelles, and to Mauritius, and the Governments had made a guarantee for 28 years. Altogether he thought they were probably in a stronger position than they had ever been.

The **Marquis of Tweeddale** seconded the motion, which was carried unanimously, without any questions or discussion.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held last Friday at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report and the payment of the dividends recommended, observed that the results of the half-year's working had been somewhat disappointing. The traffic receipts showed a decrease of £4,670 as compared with those of the corresponding period of last year, although the receipts for the year 1892 exhibited an increase of £5,365 when compared with those of the previous year. The total receipts for the half-year had been £164,365, while the total expenses had amounted to £58,628. The reason put forward to account for the decrease in the receipts of last half-year was dulness in business and keenness in competition, to meet which they were obliged to spend money. There had been net decrease in their expenses of £4,878. They had credited the reserve fund with the amount of the unclaimed dividends to December 31, amounting to £2,021. The renewal fund having for the first time reached over £1,000,000, the Board had decided to transfer £1,609 from the interest of the fund to the revenue account. This had enabled them to recommend a dividend at the rate of 30s. per cent., compared with 28s. 6d. per cent. in 1891, making a total distribution for the year of 2¾ per cent. on their ordinary stock.

Mr. Francis A. Bevan seconded the motion.

A discussion followed, practically entirely on the question of the amount standing to the credit of the renewal fund. It was argued that now that the fund amounted to nearly £1,100,000, taking into account the increase in the market value of the securities in which the fund was invested, the interest earned by it ought to be added to revenue, in order that the deferred stockholders might receive a dividend.

Mr. John Newton maintained that the revenue earned by the investments forming the renewal fund was as much revenue as that which was earned by their traffic receipts.

The **Chairman**, in reply, said that probably, with a little trouble, he might be able to state the proportions of the outward and the inward traffic over their cables, but it would not be desirable to furnish such information. With reference to the renewal fund, what Mr. Newton had said was quite right—that the deferred stockholders could not receive anything until 6 per cent. had been paid on the preferred stock, or, in other words, until 3 per cent. had been paid on the ordinary stock. They could not take merely market values in estimating the amount at the credit of the renewal fund; it must be actual sovereigns. One of the speakers had described the fund as very large, but that was by no means the case, remembering that they had four cables, and that one of them was very old and might involve them at any moment in a large outlay for renewal.

The resolution was then put to the meeting, and adopted.

DIRECT UNITED STATES CABLE COMPANY.

The thirty-first ordinary general meeting of this Company was held last week at Winchester House, Sir John Pender presiding.

The **Chairman** stated that the revenue for the half-year ended the 31st ult., after deducting outpayments, had been £43,629, and the working and other expenses, including income tax and depreciation of spare cable, had been £18,982, leaving a balance of £24,647 as the net profit of the half-year, making, with the amount brought forward, a total of £28,377, which had been appropriated in the payment of two quarterly interim dividends of 3s. 6d. each, which had absorbed £21,248; £4,000 had been transferred to the reserve fund, and a balance of £3,129 was carried forward. The revenue, as compared with that of the corresponding period of the previous year, showed a reduction of £1,773, but he thought they had good reason to be satisfied with these results, considering all the circumstances, and remembering the depression which had existed in many departments in trade. With regard to the reserve fund account, it was credited with £4,271 for interest on the investments, £3,611 for profit on the realisation of a security, and with £4,000 transferred from the revenue account, while, on the other hand, £6,301 was debited against the account for the cost of repairs, leaving the balance standing at the increased figure of £260,298. The investments now stood at a cost of £234,152, but their present market value was nearly £260,000. Taking into account the dividends paid and the market value of the various stocks, their Company was at the present moment paying probably the highest rate of interest of any of the Atlantic telegraph companies. The Company's cable was getting old, but whenever they had to make repairs they materially strengthened it, and he believed that their main line was very little, if at all, inferior to what it was when it was originally laid down. He wished the Directors could declare a larger dividend, but the shareholders must remember the depression which was prevailing, and also the fact that there were at the present time 10 Atlantic cables; in fact, as the lines were duplexed, they were really equal to doing the work of 20 cables. He thought it somewhat surprising in the circumstances that they occupied such a favourable position as they did. They would be able to meet the growth of the traffic for a long time, and he did not think there was any danger of any new Atlantic cable being laid to compete with those already existing, which were so much ahead of the requirements of the telegraphic public. The Chairman alluded to the suit between the Anglo-American and the Paris and New York Telegraph Companies, and stated that it was still pending. It was impossible to say when the matter would be finished. He concluded by moving the adoption of the report.

Mr. E. M. Underdown, Q.C., seconded the motion, which was carried.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the week ended January 27 were £3,648.

Oil - Engine.—The Roots Gas-Engine Company have now brought out a serviceable oil-engine to work with ordinary lamp paraffin.

Great Northern Telegraph Company.—Messrs. C. J. Hambro and Son announce the numbers of debentures of 1883 (series B) of the Great Northern Telegraph Company, drawn for payment on March 1.

Baden.—Projects for a central station at Baden are being considered from Schuckerts, Cromptons, and Ganz and Co.

Machine Tools.—A neat waistcoat-pocket edition of a list of machine tools is issued by Messrs. Reginald Bolton and Co., of 110, Leadenhall-street.

Personal.—Mr. W. Perren Maycock, M.I.E.E., has started in practice as a consulting engineer, and has opened an office at 96, George-street, Croydon.

Halifax.—The Gas Committee of the Corporation last Friday met to consider the applications for the post of electrical engineer, which were 63 in number. They will be further examined to-day (Friday).

Submarine Cables Trust.—Notice is given that on and after February 7 the sum of £1. 10s. (being the balance of the coupon due October 15 last) will be paid by Messrs. Glyn, Mills, Currie, and Co.

Lancaster.—At the last meeting of the Lancaster Council it was resolved to apply for permission to borrow £25,000 for the purpose of providing the installation necessary for lighting the borough by electricity.

Burnley.—The Burnley Town Council have sanctioned the acceptance of the tender of Messrs. Spagnoletti and Crookes for the supply and fixing of wires in the Town Hall for electric lighting purposes at the sum of £396.

Swindon.—At the last meeting of the New Swindon Local Board it was resolved to advertise for lighting the New Town with the electric light, commencing in January, 1894, and to divide the town into three lighting districts for such purpose.

Liverpool Overhead Railway.—A correspondent to the *Liverpool Courier* suggests that, for the protection of fingers, a leather joint should cover the crack in the doors of the carriages on the new railway, as in the best carriages of other railways.

Pupil.—The following appears in the *Daily News*: "A consulting engineer and electrician has a vacancy for a pupil. Good opening for an intelligent lad with scientific tastes. Address, 807 Q., *Daily News* Enquiry Office, 67, Fleet-street, E.C."

Newbury.—Mr. Robert Watson, writing from the gasworks, Newbury, takes up cudgels against the electric light. His letter would not be very difficult to answer if Mr. Soper, who started the controversy, or other advocates of the electric light wish to do so.

Heckmondwike.—At the last meeting of the Heckmondwike Local Board, it was decided to take a poll of the ratepayers as to whether the Board should go forward with its electric lighting scheme, and to this end the appointment of an engineer was adjourned.

St. Martin's Electrical Manufacturing Company, Limited.—This Company has been registered by W. A. Thomson, 38, Coleman-street, E.C., with a capital of £500 in £1 shares. Object sufficiently indicated by the title. Registered without articles of association.

Dundee.—At the last meeting of the Dundee Gas Committee, it was reported that the city would be illuminated with electric light in the course of a fortnight. A remit was made to ex-Provost Brownlee, convener of the Works Committee, and the electrical engineer to engage a staff.

City and South London Railway Company.—The receipts for the week ending January 29 were £976 against £823 for the corresponding period of last year, or an increase of £153. The total receipts for 1893 show an increase of £626 over those for the corresponding period of 1892.

Blackpool.—The Blackpool Corporation have applied to the Local Government Board for power to borrow £26,000 with which to complete the installation. It was stated that the promenade and principal streets will be illuminated, and that the three piers, as well as other public resorts, will also adopt the now illumination.

Lundberg's Switches.—In spite of the short time the "Unique" switches and "Unique" combination switch wall sockets have been introduced by Mr. Lundberg, they are being sold in large quantities, and are daily increasing in popularity both at home and abroad. As an instance, an order has been just received from France for 2,500 of the "Unique" combination switch wall sockets.

Cost of Electric Light.—"Glimmer," writing to the *Western Mail*, quotes Newcastle as an instance of low price while using old-fashioned boilers and steam-turbines. Then he asks any reader who happens to know if they will give some information on the subject; also at what price per unit electricity would have to be supplied to compete with gas at 3s. per thousand feet, the volume of light from both sources of course to be equal.

Telephone Exchange for Huddersfield.—Tenders are invited by the Town Council of Huddersfield for a telephone exchange switchboard connecting up the existing departmental lines, and fixing and connecting additional telephone lines. Specifications and plans may be obtained from Mr. A. B. Mountain, borough electrical engineer, Gasworks-street, Huddersfield, to whom tenders must be sent not later than Thursday, the 9th February, 1893.

Salford.—At the meeting of the Salford Town Council on Wednesday, Mr. Holland, chairman of the Gas Committee, moved a resolution to the effect that application be made to the Local Government Board for power to borrow £50,000 to cover the cost for further extensions when necessary for supplying electric lighting in the borough. It was thought that £30,000, as originally stated, would have been sufficient. Mr. Phillips seconded the motion, which was agreed to.

Bolton.—The Bolton Town Council, on Wednesday, approved of the recommendation of the Gas Committee to the effect that £40,000 be borrowed for electric lighting purposes. Tenders have been read from six firms to lay down installations, the estimates varying from £8,340 to £13,430, in addition to which there will be an expenditure of about £2,000 on buildings as a start. Before deciding upon any of the tenders the sub-committee propose visiting Birmingham. The sub-committee have also decided to have a resident electrical engineer, the commencing salary to be £200 per annum.

Hull Exhibition.—At the meeting of the Hull Electric Lighting Committee, on the motion of the Chairman an unanimous vote of thanks was passed to the exhibitors and servants engaged in the electrical exhibition at the Town Hall for the courtesy displayed by them to visitors, and similar votes were passed to the chief constable for allowing the police to attend to the visitors, to the Works Committee for the use of the Town Hall, and to the Parks Committee for the loan of the plants. He understood that throughout the exhibition had been very largely attended, and had given every satisfaction.

Barry Island Electric Tramway.—A meeting of the Barry and Cadoxton Local Board was privately held on Monday afternoon at Cadoxton, Mr. J. Robinson, M.Inst.C.E., in the chair, when the clerk (Mr. Hughes) read a letter from Messrs. Dovey and Hancock with regard to the Barry Company's Bill for the construction of an electric tramway to Barry Island, and the Board resolved to give their consent if the tramway line was moved to the north side of Barry Dock-road instead of the centre, so that facilities be thus given to the construction of another tramway thereon, if necessary.

Burton-on-Trent.—Mr. Robert Hammond lectured on "Electric Lighting—Its Present Position and Prospects," at Burton-on-Trent last week. The stage was fitted as a tastefully-arranged drawing-room, illuminated by electricity, and under these pleasant conditions Mr. Hammond lucidly demonstrated the adaptability to the home of the illuminant whose cause he was championing. At the close the lecturer was heartily thanked, on the motion of Alderman Lowe, and a similar compliment was awarded the Mayor, who presided over the gathering. The Nursing Institution, in whose interest the lecture was given, will benefit to the extent of £30.

Torquay.—Mr. William Radcliff, electrical engineer, of London and Torquay, to whom must be given the credit of lighting by electricity the first theatre and the first factory in Devonshire—Torquay Theatre Royal and Messrs. Vicary's factory at Newton respectively—has recently carried out an installation in the establishment of Mr. Berry, hairdresser, of Fleet-street, Torquay. The installation is in every respect successful. For lighting the interior of the premises there are 19 16-c.p. incandescent lamps, while outside the shop is an arc light, which illuminates the whole of this part of the street. A 2-h.p. gas-engine, situated in the basement, supplies the motive power.

Scarborough Town Council.—A special meeting of the Scarborough Town Council was held on Monday, the business being the consideration of the minutes of the Sanitary and Lighting Committee. They showed that it had been agreed to allow the Scarborough Electric Supply Company, Limited, to increase the pressure of their electric supply from 1,000 volts to 2,000 volts; and that the committee recommended, as advised by the electrical engineer of the Corporation, that 45 per cent. on the capital for the time being expended by the company on their undertaking shall be the maximum amount of the company's depreciation fund. The minutes were confirmed.

Torquay.—The Torquay Electric Lighting Committee reported at the last Town Council meeting that, having regard to the financial position of the borough, they recommended that offers be invited from companies or persons for transference to them, by way of lease (subject to the consent and approval of the Board of Trade being obtained), of the powers contained in the Torquay Electric Lighting Order, 1891. The Mayor moved the adoption of the report. Alderman Harrison moved, as an amendment, that the matter be referred back to the committee, and a specialist called in to give his advice on the subject. The amendment was carried by an overwhelming majority.

Ostend.—Messrs. Morris and Van Rysselberghe have again taken over the working of the gasworks at Ostend, says *Industries*, and are also at work upon a scheme for a central station for lighting and power purposes. The price to be charged is 1d. per 100 watt-hours, a reduction of 25 per cent. being allowed upon the current consumed by the municipal authorities. For the concession, Messrs. Morris and Van Rysselberghe have agreed to pay to the town an annual sum of £400 for the first 10 years, after which the annual payment will only amount to £40. The concession is for a period of 35 years, but the town authorities have power to take over the central station at the end of the tenth year under certain conditions.

Scarborough.—The Scarborough Electric Supply Company, Limited, who have obtained a transfer of the provisional order for Scarborough secured by the Corporation, are now getting to work. A site for the supply station has been decided upon at Salisbury-street, on the west side of the town, near the railway, and building operations will be commenced forthwith. The contract for the whole of the generating plant, including engines, alternators, condensers, boilers, etc., has been placed with Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne, whose price was considerably less than the other tenders received in response to the specification, and who also guaranteed with their steam-turbine alternators the lowest steam consumption per unit at all loads.

Brisbane.—The electric light is rapidly coming into general use in Brisbane. For some time past the Gresham Hotel was the only hotel in Brisbane lighted by this means, but Mr. Leon Erckmann, the proprietor of Lennon's Hotel, Brisbane, and late manager of the Hotel Metropole, Sydney, and Grand Hotel, Melbourne, has had the light installed throughout his premises. For coolness and cleanliness, the incandescent electric light seems, in the hot climate of the district, to be almost indispensable. The lights on the outside balcony give the hotel a fine appearance from the road at night time. Messrs. Barton and White, of Edison-lane, Creek-street, Brisbane, erected the installation.

Cambridge.—At the half-yearly meeting of the Cambridge Gas Company the chairman said that although he dared say there was a scare in some quarters, and some thought they would be most seriously affected by the electric light—and perhaps they might be somewhat affected—yet he believed that permanently they would be able to carry on the company with prosperity. Permanently he did not believe they would receive any damage from the new company and the electric light that had been brought in. He was sure they had no ill-feeling towards the electric light company, and so long as they conducted their business in an honourable and fair way they wished to work amicably with them, and would always endeavour to do so. He was not at all opposed to the electric light; it was a cleanly light, but there might be some disadvantages that might prevent it being used so much generally, and the increase in the amount of gas supplied gave them great hope for the future.

Maidstone—Mr. Hawtayne has presented a scheme for electric lighting to the Maidstone Local Board. He proposes to erect a supply station at the sewage works to generate a current for 2,000 16-c p. incandescent lamps, of which 500 are to be distributed among public buildings, and the remaining 1,500 to be furnished to the shops and houses requiring them. Mr. Hawtayne suggests the abandonment of street-lighting for the present, or until such time that the profit in the supply of electricity to private consumers will justify outlay on the improvement of public lighting. The current is to be brought from the sewage farm to the town by overhead cables running along the towing path. With 20,000 lamps installed, he thinks that the average number in use at one time will be about 1,300. He calculates the amount of electricity likely to be sold at 100,000 units. At 6d. per unit this would represent an income of £2,625. At 8d. unit it would represent an income of £3,500. Mr. Hawtayne takes the charge of 6½d. per unit as about the equivalent of gas of 6s. 6d. per 1,000ft.

Blackpool Contracts.—"Public confidence in the manner in which the electric lighting contracts are being managed does not seem to be particularly strong," says a Blackpool paper. "A correspondent has pointed out that almost contemporaneously with Corporation contracts being given to a London and a Manchester firm, advertisements of an unusual size from the very same firms appeared in our Friday contemporary. The inference naturally drawn was that the members of the Town Council who have recently become the owners of our contemporary have brought such influence to work as to secure for their advertising-sheet such marks of favouritism as these extended advertisements indicated. If public policy and private interests do not clash, not a word can be said in objection. But if public policy—the safeguarding of the interests of the ratepayers—is to be subordinated to the exigencies of advertisement canvassing by members of the Town Council, if those elected by the ratepayers are to use their positions to secure subsidies for a venture in which they are privately concerned from firms who do business with the Corporation—then it is time to speak out."

Southampton.—The Estates Committee of the Southampton Town Council recommended the Corporation to light the Audit-house and Municipal Offices by electricity at a cost not exceeding £180, and to instruct the town clerk to advertise for tenders for the supply. Mr. Walton moved the adoption of the report dealing with the electric light. He contended that such a change as was proposed would be very advantageous both to the Council and to the officials of the Corporation. Alderman Payne said that in a few years, when Southampton became really the Liverpool of the South, they would be under the necessity of building a town hall, and it would be well not to spend money unnecessarily. Mr. Emanuel was in favour of the electric light, but he should move that the matter be deferred for the present, or till it was seen how the electric light acted at the Free Library, where the power would be supplied on the premises. Alderman Cleveland reminded the Council that in years past the Council decided not to light the Municipal Offices with electricity. The Mayor said they had allowed the electric light company to come into the town, and were debarred from laying anything in the streets. The report was withdrawn.

Nottingham.—Writing to the *Nottingham Daily Guardian* of the 2nd inst., Mr. A. Burgess gives the synopsis of the statements which have caused him most uneasiness, in the hope that some friend will come forward and dispel his anxiety. "To the best of my recollection the statements were as follow: (*a*) That the system of generation and distributions proposed for Nottingham is one involving the use of storage batteries and motor-generators, and that it is the most expensive and complicated of any of the existing systems. (*b*) That in the isolated cases where it has been employed the shareholders have never received any dividend, although the prices charged to consumers are very high. (*c*) That no engineer of repute has ever recommended this system. (*d*) That the town of Nottingham is to be saddled with this system not through any fault of its own, but simply by reason of the accidental selection, through advertisement, of an engineering manager for the projected works who was educated and brought up on batteries and motor-generators, and has had no practical experience whatever of any other system. (e) That no sufficient reason can be shown for the adoption of the Willans engine in Nottingham, where land is plentiful and money scarce."

Colchester.—At a special meeting of the Colchester Town Council last week, Mr. Hazell moved "That application be made by the Mayor, Aldermen, and Burgesses, acting by the Council as the urban sanitary authority of this borough, to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, for a provisional order enabling them to produce and supply electricity for public and private purposes within the borough; and to levy, make, and recover rates and charges therefor; and to break up streets and railways; and to cross rivers and canals; and lay electric lines; to manufacture, hire, sell, and let electric apparatus; and exercise other incidental powers. And that the town clerk take all necessary steps to obtain such order and the confirmation thereof." Mr. Hazell observed that this was identical with the resolution which was passed unanimously by the Council, after full discussion, about a month ago. It was totally unnecessary for him to add anything to what he said then, and he would simply move the resolution as it stood. The town clerk would give them the legal reason for the motion. The town clerk explained that the resolution was necessary under the Electric Lighting Act, which stated that no application for a license should be made by any local authority, excepting in pursuance of any resolution passed previously, after one month's previous notice, and for the purposes thereof a memorial was necessitated under the rules of the Board of Trade. The resolution was carried unanimously.

Steam Yachts.—The season of 1893 will see two notable additions to the pleasure navy of the world in the shape of two large steam yachts now being built to the designs and under the superintendence of Mr. St. Clare Byrne, of Liverpool, designer of "Lady Ina," "Amy," "Jeanette," "Norseman," and a host of other well-known steam yachts. The first of the new yachts is being constructed by Messrs. Napier, Shanks, and Bell, Yoker, for that keen and enthusiastic yachtsman Mr. N. B. Stewart, who has probably built and owned more yacht tonnage than any man of the day, and whose succession of "Amys" have been so well known on the Clyde. The new vessel will be rather over 800 tons. Messrs. D. Rowan and Sons, of Glasgow, are building the engines, which will be triple expansion. She will be lighted by electricity throughout, and will be fitted with every up-to-date contrivance, and turned out as near perfection in the yacht line as possible. Mr. Byrne has previously designed for Mr. Stewart the "Amy" of 400 tons, followed by the "Amy" of 650 tons, so that the present ship is the third he has turned out for him. The other new vessel Mr. Byrne has in hand is somewhat of a leviathan in the pleasure fleet, and will be probably the largest private yacht in existence. She is being built by Laird Bros., of Birkenhead, for Mr. Vanderbilt, to replace the "Alva" (run down and sunk last year), which vessel was also designed by Mr. Byrne. This vessel will be fitted with electric plant, all in duplicate, with every other modern improvement that can make her a floating palace.

Electric Tramways for Brisbane.—The half-yearly report of the Metropolitan Tramway and Investment Company, Brisbane, mentions that the directors have made arrangements with Mr. G. S. Duncan, C.E., the eminent engineer to the Melbourne Tramway Trust, to visit the United States of America and report on the advisableness of adopting the electrical overhead system as a motive power, and that Mr. Duncan has spent June, July, and August in the States, visiting many cities widely apart, and consulting with the leading tramway engineers and experts. He strongly recommends the adoption of the overhead trolley system, as being peculiarly suited to the requirements of Brisbane. He found over 400 companies using this power, giving excellent results to the shareholders, and satisfaction to the travelling public. He advises that a really first-class power and generating plant be laid down. This he considers imperative, as none other will give satisfaction; that the lines be relaid with heavier rails, special attention being paid to the joints; the surface of the roadway to be paved with wood blocks in the busier thoroughfares where traffic is heavy; also, that improved cars of a later pattern be substituted for the cars now in use, which can be utilised as trail cars. The amount required for the carrying out of this work (with extensions) he estimates at £200,000, and thinks that a good dividend can be paid on the whole capital. The directors have had the report under their careful consideration, and as the working expenses under this system do not average more per car-mile than half the present cost, and the increase of traffic may from experience be great—as much as 100 per cent. in some cities in America—they have resolved to adopt the system recommended, provided the necessary capital can be raised. Certain local arrangements must be first completed. Application has also been made to the Governor-in-Council for an order for the extension of time to 25 years. The directors hope to be able to announce shortly that all concurrences have been obtained, and the way cleared for action. They have formally offered the system for sale to the various local bodies as provided in their Act, so removing all obstruction to future operation. Extensions are to be made at the same time to make the lines a success. The car-mileage run was 405,549 miles, and number of passengers carried 1,189,812. The proposed alteration should have the attention of British electrical engineers.

Telephone Subscribers.—The following notice has been issued by the Association for the Protection of Telephone Subscribers: "The amalgamation of the New Telephone Company with the National Telephone Company brings back the old vicious *status quo*, and makes the maintenance of this association more than ever necessary for the protection of our interests. Whether, or to what extent, the Board of the New Telephone Company have, in handing over their embryo system to the National Telephone Company, reserved the rights accorded to our association by the agreement of April, 1892, remains to be seen; but both companies have been served with notices claiming our legal rights under that agreement, which was duly cited in the prospectus of the New Telephone Company. By that agreement the company undertook to put up, and to remove if called on, a telephone on their system for our subscribers gratis, up to the expiration of the then current annual subscription to the National Telephone Company; and for £12. 12s yearly thereafter. Since its formation our organisation has undoubtedly had the effect of bettering to some extent the exasperating and imperfect telephonic service; though this amendment was also due in part to the stimulus of a competing system. Unfortunately for the public this competition has now been bought up. The old monopoly will now have about another million sterling of capital to carry, the dividends on which, as well as on the former inflated capital, will have practically to be paid by us subscribers. It is therefore more than ever incumbent upon us to band ourselves together to protect our common interests, as well as to enforce our legal rights; and as an adherent in the year 1892, you are invited to send the subscription of 5s. for the current year. Our association is registered as a company, limited by guarantee, which gives us a proper *locus standi* before Parliament and elsewhere; but the annual subscription entails no liability whatever. As we understand the New Telephone Company has, in addition to agreeing with our association collectively, made contracts with individuals for the supply of a telephone at £12. 12s. per annum, we shall be glad to receive the co-operation of any such persons; who will, if they become subscribers, receive the advice and support of the association. The late secretary, Mr. S. H. Fry, is no longer in the service of the association, and is not authorised to represent it in any way.—By order, C. W. Rawlinson, sec. *pro tem.*, 58, Coleman-street, E.C., January 24th, 1893."

South Staffordshire Electric Tramways.—A report has been made to the Board of Trade by Major-General Hutchinson and Major Cardew with reference to the new electric tramways which were recently instituted by the South Staffordshire Tramways Company on the Walsall, Wednesbury, Darlaston, and Bloxwich lines. The former gentleman, in his report, states that considerable repairs had been executed, both as regards paving and rail points, since he last inspected the lines, and their condition was now, on the whole, satisfactory. The traction was conducted on the overhead wire system, the cable being carried on brackets projecting from steel tubular posts fixed along the kerbs of the footpath. In passing round curves, and at passing places, there was, of course, a great strain upon the posts, which had in two or three instances got slightly out of the vertical position, and should be restored to that position. It would be desirable, where practicable or necessary, to obtain permission to secure the posts by backstays fastened to the walls of adjoining houses. A description of the cars follows, each of whom was fitted with two wheel brakes, one for ordinary use, and the other for emergencies. The reversal of the current could also be resorted to when a specially quick stop was necessary. The action of the ordinary brake was not as quick as it might be made, and the tramway manager had promised to have the action improved in this respect. The tractive power seemed fully adequate to the haulage of the car used at the inspection up the steepest gradients of the line. Similar regulations as to stops and restriction of speed would be necessary as in the case of steam haulage on the same lines. Subject to these regulations and the improvements mentioned, he could recommend the Board of Trade to sanction the use of electrical traction on the above defined portions of the South Staffordshire Tramways. Major Cardew in his report makes mention of three requirements as follows: (1) The covers of the surface-boxes at feeding points should be so secured that they cannot be opened by unauthorised persons. (2) The negative terminal of each of the dynamos should be metallically connected to the system of water-supply pipes if available, in order to secure that the whole electrical circuit external to the dynamo is at all times and throughout at an electrical potential positive with regard to these pipes and the general earth. (3) Guard-wires or other efficient protection to be provided at all points where telegraph or other wires cross the conductor. These reports are regarded as exceedingly satisfactory, and the improvements suggested have been or are being carried out.

Cardiff.—The correspondence in the *Western Mail* on the electric light goes merrily on. Mr. Sydney F. Walker, of course, is in the field. The price of 6d. per unit is his ideal, with the use of large incandescent lamps in the streets. "The arc lamp," he says, "is dying—dying hard, it is true, but its end cannot be far off all the same. There are loud complaints in London of its behaviour at the British Museum and other places. I understand that the electric-light linemen are provided with tricycles, ready to go at top speed to any lamp that is failing, the men being kept on in relays all night, and the policemen being instructed to warn them of the failure of any lamp. Surely, when this pass is reached—when the supply company are obliged to pay for labour of this kind if they do not wish to incur heavy fines—it is time for a young and rising town like Cardiff to say good-bye to the old friend we have known so long." Mr. G. Southey, engineer, submits some figures as to cost of generating electricity and the charge to consumers in other towns: "Taking 13 different companies' charges, the average comes out at 7·17d. per unit. The charges vary from 8d. to 4·22d. per unit. One of the principal factors for regulating these prices is the cost of coal. This varies from 2·32d. per unit (London Electric Company), who charge the consumers

7·25d. to 0·53d. per unit in Bradford, where the charge to consumers is 6d. The management expenses vary from 5·43d. per unit (London Electric Company) to 0·82d. in Bradford. In Exeter the charge to consumers is 7·5d. per unit, and here there is an apparent profit of 3·23d. At Newcastle-on-Tyne the charge is 4·22d. per unit and the profit 1·61d. The St. James and Pall Mall Company, London, charge 7d., and make a profit of 2·23d. The price at which electricity would have to be sold to compete with gas at Cardiff depends a great deal upon what style of lamps, globes, or burners is used in either case. But 3s. worth of Cardiff gas will give a light for one hour equal to about 3,200 candles, and one unit of electricity used in ordinary incandescent lamps will give a light for one hour equal to about 250 candles. The cost of renewing the incandescent lamps would amount to about 0·75d. per unit used, so that the current would have to be supplied at 2·06d. per unit. One unit of electricity used in arc lamps will give a light for one hour equal to about 2,000 candles, and the cost of replenishing carbons would be about 0·16d. per unit used. So for arc lighting current might be supplied at 22·34d. per unit. In the case of gas I have made no allowance for the breakage of chimney globes, which to large consumers is no small item. Again, the Edison and Swan Company have now put what they call a 'high efficiency' incandescent lamp for larger candle-power in the market, and this lamp, they claim, will give double the candle-power per unit used as compared with the ordinary incandescent lamp."

PROVISIONAL PATENTS, 1893.

JANUARY 23.

1416. **A new or improved electric alarum for use in hotels or other large buildings, or otherwise.** Louis Gustav Weygang, 3, Hermitage-villas, Child's Hill, London.

1435. **An improved supporter for the receivers of telephones and the like.** Andrew Connell, 8, Quality-court, Chancery-lane, London.

444. **Improvements in electric storage battery plates.** Ernest Bailey and John Dunham Massey, Broad-street House, London.

1449. **Electrical hose signalling apparatus.** William Fowler, 52, Chancery-lane, London. (Complete specification.)

JANUARY 24.

1502. **Improved process and apparatus for the electrolytic production of porous finely subdivided lead for use in secondary batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Erich Correns, Germany.) (Complete specification.)

1528. **Improvements in the electrical insulation of wires.** Walker Moseley and Ernest Oldenbourg, 60, Watling-street, London.

1561. **Improvements in dynamo-electric machines or electric motors.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell and Edward Hibberd Johnson, United States.) (Complete specification.)

1574. **Improvements in current adapters for incandescent electric light circuits.** John Corry Fell, 1, Queen Victoria-street, London. (Alexander Frank Vetter, United States.)

1579. **Improvements in connection with electric bells.** Louis Gustav Weygang, 3, Hermitage-villas, Child's Hill, London.

1592. **Improvements in the method of, and means for, the production electrically of spectacular effects.** Alexander Leslie Fyfe, 22, Southampton-buildings, Chancery-lane, London.

1595. **Improvements in carriage attachments or dial indicators and electric light fittings.** Peter Jensen, 77, Chancery-lane, London. (Arthur Middleton Blake, United States.)

JANUARY 25.

1610. **Improvements in electric heating apparatus.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

1615. **Improvements in electrical accumulators.** Nicholas Stanton Hill, 73, Cheapside, London. (Iwan Nicolariff, Russia.)

1620. **Regulable electric lamp.** George Hall and Joseph De Marr, 89, Chancery-lane, London. (Complete specification.)

1621. **An improved system of distribution for polyphase alternating currents.** Charles Schenck Bradley, 70, Wellington-street, Glasgow. (Date applied for under Patents Act, 1883, sec. 103, July 29, 1892, being date of application in United States.) (Complete specification.)

1661. **Improvements in electrolytic apparatus.** Emile Andreoli, 61, Chancery-lane, London. (Complete specification)

1675. **Process for treating the effluent from electrolytically or chemically-purified sewage for neutralising its alkalinity, and for the production of by-products therefrom.** William Webster, 28, Southampton-buildings, Chancery-lane, London.

1683. **Improvements in electric arc lamps.** Frank Godfrey Lott, 9, Warwick-court, Gray's-inn, London.

1697. **An improved electric clock.** Gustav Binswanger and Herbert John Coates, 11, Furnival-street, London.

JANUARY 26.

1720. **An improved electric alarm.** Matthew Cranswick Greenhill, 11, Romola-road, Tulse-hill.

1759. **Improvements in electrical apparatus for use in ships' telegraphs and other purposes.** George Frederick Flemmich, 7, Albemarle-street, London. (Complete specification.)

1778. **Improvements relating to the coating of articles with alloys by electro-deposition.** The London Metallurgical Company, Limited, and Sherard Osborne Cowper-Coles, 45, Southampton-buildings, London.

JANUARY 27.

1812. **Electric light regulating switches.** Robert John Sansome and Henry Hawes, 69, St. James's-road, Southsea.

1829. **An improvement in electrical transmitters.** William Alfred Morrison Brown, Ash-grove, Victoria-road, Leeds.

1840. **Improvements in and connected with electric signalling on railways.** Thomas Ellis Dean, 70, Market-street, Manchester.

1849. **A new and improved form of two-way electric switch.** Alfred Sharman Giles, 34, Victoria-street, Westminster, London.

1863. **Improvements in the manufacture of insulators such as are used in electric lighting.** Henry Lewis Doulton, 24, Southampton-buildings, Chancery-lane, London.

JANUARY 28.

1892. **Improvements in voltmeters, ammeters, and similar instruments.** Robert Alfred Wormall, The Elm, 61, Park-lane, Croydon.

1894. **Improvements in self-regulating dynamo-electric generators and motors.** Illius Augustus Timmis and Alfred Ivor Smith, 2, Great George-street, Westminster, London.

1895. **An improved and simple means of procuring a "dead-beat action" of a coil or coils of wire, suspended and moving horizontally or vertically in a magnetic or electromagnetic field of force.** Thomas Clark and William Bradley Redgrave, Enderby's Wharf, East Greenwich.

1902. **Improvements in or relating to metallic junction-boxes for concentric electric conductors, and in the mode of connecting conductors therein.** Henry Alexander Mavor, William Arthur Coulson, Sam Mavor, and William Brook Sayers, 56, George-square, Glasgow.

1948. **An improvement in secondary voltaic batteries.** Harold Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour le Travail Electrique des Metaux, France.)

1956. **Improvements in dynamo electric machines.** Silvanus Phillips Thompson and William Morris Mordey, 46, Lincoln's-inn-fields, London.

1958. **Improvements in electric telegraphs and mechanism in connection therewith.** Sir James Anderson and Angus Fraser, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1885.

2765. **Secondary batteries.** Lake. Marchenay. (Second edition.)

1892.

3538. **Electric currents in mines, etc.** Charleton and Walker.

4276. **Electric meters.** Paul.

4427. **Telephone switchboard systems.** Kingsbury. (Western Electric Company.)

4428. **Telephone switchboard systems.** Kingsbury. (Western Electric Company.)

5750. **Electrical switch.** Johnson.

10466. **Telephone combination.** Forbes.

18025. **Electric elevators.** See and Tyler.

21613. **Telephonic transmitters.** Groper.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5	5½
	3	3¾
London Electric Supply	5	¾
Metropolitan Electric Supply	—	7
National Telephone	5	4¾
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	6

NOTES.

Carlsbad.—A concession has been granted for an electric railway to the Kaiserpark in Carlsbad.

Electric Boats.—On the Gmundsersee and Attersee electric boats, driven by accumulators, will shortly be run.

Civil Engineers.—On Tuesday Dr. Edward Hopkinson will read a paper on the "Electrical Railways" before the Institution of Civil Engineers.

Elections.—Mr. Walter Emmott, Halifax, and Mr. Ernest George Tidd, of South Kensington, have been elected associate members of the Institution of Civil Engineers.

Telephones on Railways.—At the Société des Ingénieurs Civils on March 3 a paper will be read by MM. G. Dumont and E. Bernheim on "The Use of Telephones on Railways."

Electric Heating.—The United States Government are stated to be seriously considering the abandonment of all other lighting and heating on one of their military posts except that obtainable from electricity.

Use of Small Motors.—A paper will be given before the Junior Engineering Society, at the Westminster Palace Hotel, to-day, Friday, by Messrs. D. T. and A. C. Heap, on "The Application of Small Power Electric Motors."

Electricity on Board Ship.—On Monday, before the North-East Institution of Engineers, at Newcastle, a paper will be read by L. Newitt "On Ship's Electrical Fittings for Lighting, Signalling, and Telegraphing."

Proposed Cable to New Caledonia.—At a Cabinet Council held in Paris, approval was given to the convention submitted by M. Delcassé, Under Secretary for the Colonies, for laying a submarine cable between New Caledonia and Australia.

Lecture by Nikola Tesla.—It is announced that a lecture by Mr. Nikola Tesla will be given before the National Electric Light Association this month. The lecture will be illustrated by numerous experiments, and is being looked forward to with great interest in America.

Transmission of Music.—A description, with diagrams, of transmission of music by Berliner's apparatus is given in the *Zeitschrift für Elektrotechnik*, February 1. Ten transmitters and six induction coils with 60 Callaud cells were used. The opera music was successfully transmitted from Munich to Frankfort.

Lecture.—A lecture on the "Present Uses of Electricity" was delivered by Mr. T. Bolas, F.C.S., at the Schoolroom, Turnham Green, on Friday evening, in connection with the Turnham Green Scientific and Literary Society. Commander Robinson, R.N., presided. There was a large attendance. The lecture was illustrated by numerous experiments.

The Electrical Dog.—The *Daily Graphic* yesterday contains a portrait of "Strip," the electrical dog, who after helping to lay many miles of cable in London has lately been in Brighton with the same object. "Strip" is the clever little fox-terrier who works for Crompton's, by passing along the conduits carrying the drawing-in cord. The engraving was taken from a photograph of the dog by Lieut.-Colonel F. K. Lloyd, near whose house "Strip" has been working.

Handy Transformer.—The transformer known as the Diamond, is described in the *Electrical World* received last week—a very convenient form. The laminated strips are ploughed out in two grooves; in these are slipped, flat side on, the two coils, the primary uppermost, so as to be easily got at in case of burning out. The coils are shut in by an iron case with double lid; the outer lid contains the fuse wires, and the act of unlocking and opening disconnects the fuses.

Smoke Prevention.—A German invention for the consumption of smoke, said to be very satisfactory, consists in the reduction of the coal by grinding to a very fine powder. The inflammable dust is injected into the furnace by a current of air automatically regulated, and burns with fierce blaze. Oxygen being introduced by a new contrivance the powder floats in space, being consumed to the utmost particle, and no smoke is given off, while the fire is easily regulated and fed.

Electric Cure for Drowning.—Electricity has been successfully used in restoring life to a man who had apparently been drowned, according to a story from Scotland. The man, while bathing, was seized with cramp and sunk, and remained below water for two minutes. When rescued, he was believed to be dead; but two applications of the electric current, which was passed between the nape of the neck and the heart, restored him to animation, and he ultimately recovered.

Artificial Indiarubber.—Dr. Tilden's discovery, to which reference has been often made lately, is that isoprene (C_5H_8) liquid prepared by the action of heat upon turpentine, undergoes a spontaneous change in the presence of acid and becomes caoutchouc. This artificial caoutchouc is identical with the natural in its composition, consisting of two substances, of which one is more soluble than the other in bisulphide of carbon or benzol; and it vulcanises in the same way.

Howard Lectures.—The fifth lecture by Prof. Unwin, on "The Transmission of Power from Central Stations," will be given to-night before the Society of Arts. The sixth lecture, next Friday, the 17th inst., will deal with the distribution of mechanical energy by electricity; systems hitherto adopted; examples of distribution of motive power electrically; Hersthal installation; Niagara scheme; advantages of combined schemes, heat and power; light and power; water supply, light and power.

Cantor Lectures.—The third Cantor lecture by Prof. Fleming on the "Practical Measurement of Alternating Currents" will be given on Monday, at the Society of Arts. It will deal with: Apparent and real power: power factor of a circuit; power-meters and wattmeters; electrostatic and electrodynamic forms of wattmeter; wattmeters for inductive circuits; wattmeters employed on high-tension circuits; methods of testing efficiency of alternators and transformers; methods of regulating pressure on testing circuits.

Gazogenes and Gas-Engines.—The interest aroused in the use of large gas-engines in recent articles will give a value to the description of the French gazogene apparatus on the Buiré-Lencauchez system, constructed by Messieurs Matter et Cie., of Rouen, given in the *Revue Industrielle* (58, Chaussée d'Antin, Paris) for February 4. A diagram of the arrangement of pipes and reservoirs for the manufacture of heating gas is given by M. Chevillard, as well as a perspective view of the gas-engine plant complete.

Train-Lighting.—Preparations are being made for lighting the Berlin-Hamburg trains by electricity. Lamps of 8 c.p. to 10 c.p. will be used, supplied by sets of accumulators. The Italian Mediterranean Railway has now, it is reported, introduced electric lighting in the carriages throughout. Each carriage has 10-c.p. lamps, the light being thrice as good as that of gas or oil. Accumulators are used, charged at the termini to last 30 hours. The

Italian railway is the first in Europe to definitely adopt electric light throughout.

Dynamo Brushes.—A special kind of dynamo brush made by M. Boudreaux is coming into use in France. Extremely thin sheets of an alloy of copper, zinc, and silicium are taken, and after folding are compressed under heavy pressure to the size of the brushes. Each millimetre of section contains 40 sheets of two to three hundredths of a millimetre thick. The use of this extreme thinness of metal gives a very soft contact, which does not wear the commutator, and enables the brushes to last long even when discharging 600 amperes for electroplating. The exact composition of the alloy is not disclosed.

Electrical Coast Communication.—A telephone line has been completed connecting the coastguard stations at Studland Bay, Swanage, St. Alban's Head, Bottom, and Kimmeridge. There was already existing a line of telegraph from St. Alban's Head coastguard station to Corfe Castle Post Office. This has been extended to Poole Post Office, and a night bell fixed there. Poole has a wire to Southampton Post Office, which is open always, and Southampton has a wire to Weymouth, where a night bell has been fixed. Thus the coastguard stations now connected will be able to communicate with Weymouth through St. Alban's Head, Poole, and Southampton.

Frohlich's Meter.—The electric meter patented by Oscar Fröhlich, and assigned to Messrs. Siemens and Halske, consists of a soft iron bar capable of oscillating on a central axis, two coils through which the current to be measured, or a certain fraction of it, is made to flow, one wound transversely and the other parallel to the iron bar; means consisting of a polarised relay, intermediate mechanism, and circuit connections for alternately reversing the direction of the current through the coil wound parallel to the iron bar. The effect of the oscillation is somewhat that of a hairspring of a watch, or the escapement of a pendulum, and the oscillations are indicated by a set of gears and escapement in the usual way.

Electrical Micrometer.—An ingenious instrument for measuring the expansion of minute solid bodies has, says the *Engineer*, been invented by Mr. J. Joly, of Dublin. The substance is placed in the field of a microscope, and a greatly enlarged image of it is thrown on a screen. This image is further magnified by two micrometer microscopes, which serve to measure the expansion. The substance is heated in a little platinum oven traversed by an electric current, and the temperature in the oven is determined by observations on the melting of standard substances. In this way it has been found possible, for instance, to determine the thermal expansion of the smallest diamond until the temperature of combustion is reached.

Electric Cranes.—In the Machinery Hall at Chicago the Yale and Towne Company, of Stamford, Conn., has installed the first of the three great travelling electric cranes. Each crane will run on a 1,400ft. track. It will be worked by a double trolley weighing of itself 50 tons, and be capable of carrying a load of 20 tons. It is driven by five motors of the Manchester slow-speed type, built by the United States Company. The largest motor, which is of 25 h.p., propels the crane itself, while two 10-h.p. motors work the hoist. The cross motion is taken care of by two 3-h.p. motors. The crane can travel at the rate of 500ft. a minute. During the Fair it will be fitted up for the accommodation of passengers, carrying 300 at a time, and will give an excellent view of the interior of the huge building.

Windmill Electricity.—A note in the *Daily Chronicle* contains a suggestion which we commend to electrical engineers as follows: "A windmill will drive a dynamo for the purpose of generating the electric current, and although an unsteady power is objectionable, there are breezy neighbourhoods where the winds are fairly constant during part of the 24 hours of the day. A set of storage batteries would assist in utilising all the current which could be generated by the windmill and its dynamo. The Cambridge show of the Royal Agricultural Society next year may be too soon for exhibitions of this class, but we shall find the electric engineers bestirring themselves at some of the future shows. Farm work is already done at Hatfield by means of the electric motor, and Lord Salisbury's example will some day be followed at many a homestead throughout the country. The field is almost unlimited."

Rating of Machinery Bill.—A conference was held at the House of Commons on Wednesday between a large number of members interested in this Bill and the committee of the Association of Machinery Users. Among those present were Sir W. Holdsworth, Bart., M.P.; H. Smith Wright, M.P., W. E. M. Tomlinson, M.P., T. H. Sidebottom, M.P., E. Strachey, M.P., Mr. F. W. H. Campbell, W. Mather, M.P., W. H. Holland, M.P., J. M. Cheetham, M.P., J. W. Sidebotham, M.P., Mark Oldroyd, M.P., Mr. W. B. Brodrick. Mr. Humphreys-Davis, the secretary of the association, reported generally as to the present position of the question in the manufacturing districts and the work that had been done during the recess. The terms of the Bill were discussed and settled and various arrangements made for the debate on the 8th prox. Mr. Holland, M.P. for North Salford, was warmly congratulated on his good fortune as a new member in securing the first day open to private members for this Bill.

Suggestions for Meters.—Mr. S D. Mott (in the *Electrical World* for January 28) has a second article on metering devices. In this the suggested meter utilises the law of angular currents as follows: (1) two rectilinear currents, the direction of which forms an angle with each other, will attract when both approach or recede from the apex of the angle; (2) they repel if one approaches and the other recedes from the apex. Each magnetic particle is considered as constituting a voltaic circuit, a magnet being made up of a number of these, arranged symmetrically. To utilise the said law, a magnet is mounted on pivots so as to be free to revolve, and in revolving to turn a train of gears: in the bottom of the apparatus is a conducting medium, preferably of mercury, to which the current is led, finds its way to the magnet, and issues at the top of the magnet. When the current is flowing the magnet will rotate on its axial line in the direction of the hands of a clock when viewed from the bottom or N end, and the speed of revolution will depend on the strength of the magnet and the strength of the current.

Boiler Economy.—The attention of electrical engineers is directed upon the wasteful portion of their plant—the boilers—in order to obtain an efficiency more approximating to that which they are accustomed to obtain from their dynamos. Any piece of apparatus that will achieve a saving is watched with anxiety and tested with interest: so that when a saving of 20 per cent. or so in the fuel required for water-tube boilers is announced, a flutter in the engineers' offices may result. We mentioned some weeks ago in a short note that M. Zakihian (297, Vauxhall Bridge-road) had been working on a device for increasing the steaming power of boilers. This consists of a simple piece of apparatus to be slipped into the tubes. We have now seen reports from Mr. D'Alton, engineer-in-chief to the London Electric Supply Company, of tests made at Deptford with this apparatus. In the first experiment Mr. D'Alton's assistants found the saving as much as 30 per cent., and he naturally hesitated in giving his sanction to certifying such a result. A further careful test extending over eight hours has produced results showing an economy of 25 per cent., and this extraordinary result is now certified by him to the inventor. The principle is ingenious, depending on a method of increasing the water circulation, and the certificate of Mr. D'Alton cannot but have the result of calling wide attention to this invention.

The Westinghouse Lamp.—The new Westinghouse incandescent lamp has been exhibited at a Press view. The pear-shaped globe is retained, but the lower end is thickened like a bottle, and ground for a stopper. The stopper is ground to fit. Iron is employed instead of platinum for the wires, a metal being required not fusible at the temperature of melting glass, and iron was chosen, platinum being too expensive. The filament having been attached to the wires, the stopper is covered with a cement and tightly introduced into the neck, and the lamp is exhausted and sealed off at the other end. The process described in the specification of the Sawyer-Man patent is now employed, nitrogen gas being introduced to wash out the remaining oxygen. The vacuum is very high, and the gas left being, moreover, only attenuated hydrogen. The atmospheric pressure tends more tightly to seal the stopper, and the cementing material, being elastic, is warranted not to crack. By warming, it softens, allowing the stopper to be removed on admitting air to the bulb, but the atmospheric pressure prevents accidental removal or loosening. The lamp is complete without base. By simple pressure its shoulders are held in springs, and a twist connects it to the contacts. The manufacturers state that the use of iron instead of platinum does not occasion a leakage. The lamp is simple and of good appearance, and its extreme cheapness has been the quality carefully aimed at by the company.

Handbooks for Engineers.—The well-known publishing firm of Whittaker and Co. have been very busy of late with electro-technical handbooks, and in a prospectus which we have received the list of these useful books is given. A work on "The Dynamo," by C. C. Hawkins and F. Wallis, is in the press; a new edition of "The Management of Accumulators," by Sir D. Salomons, is likewise to appear. "Dynamo-Machinery," by Dr. E. Hopkinson, is out and will be appreciated by practical and theoretical men alike. In the Specialist Series which have already appeared, Lodge on "Lightning Conductors" is a well-known controversial classic, if the term be allowed; "Electric Light Cables," Mr. Stuart Russell, is a deservedly successful volume; while Kapp's "Electric Transmission of Power" should be on every engineer's table. We have Preece on "The Telephone," Carl Hering on "Electric Railways," O. T. Crosby and Dr. Louis Bell on the same subject; Prof. Houston's "Dictionary of Electrical Terms," Fleming on "Transformers," Poole's "Telephone Handbook," besides works on electric light fitting, motors, turbines, plating, and so forth. We ought also to mention, while technical schools are springing up around, a notable book, by a celebrated architect and educationalist, Mr. E. C. Robins, F.S.A., on "Technical School and College Building." The list shows a great activity of these enterprising publishers to satisfy engineers' and students' wants.

Science in Australia.—Before the members of the Electrical Club of New South Wales, Mr. E. R. Dymond, on the 29th March, read a paper on "Central-Station Lighting on the Crompton System." This paper gave rise to a very interesting discussion on the 13th of the following month. In April Mr. T. P. Moody contributed a supplementary paper on "How Nature Produces Gold" to the *Proceedings* of the Northern Engineering Institute. In the same month Mr. W. A. Tourney Hind read a very discursive and statistical paper on the "Electrical Lighting of Sydney and Suburbs" before the Engineering Association of New South Wales. Following close upon this, Mr. R. Oxlade delivered an instructive paper on "Insulation Resistance" to the members of the Electrical Club. In August Mr. J. H. D. Brearley read an abstruse paper on "Alternate-Current Motors," upon which a very interesting discussion took place. On the 10th of November an instructive discussion took place at the meeting of the Engineering Association of New South Wales, on Mr. Diamond's paper on "Some Notes on Dynamo-Driving by Compound Engines." Mr. P. B. Elwell, in December, read a paper on "The Application of Secondary Batteries to Electric Traction" before the Electrical Club of New South Wales, and the debate upon this paper, which will take place early in the year, promises to be very interesting. From this brief extract it will be apparent that the engineers of the colony have been busy during the year which has passed—a good augury for the future.

Induction at Great Distances.—At a meeting of the Royal Society of Edinburgh, Mr. C. A. Stephenson, C.E., read a paper on "Induction at Great Distances through Air and Water without the use of Parallel Wires," as a means to the electric signalling of ships at sea. At the beginning of last year he had proposed, as he explained, that a cable might be laid down in the sea, and, by changing the electric state of the cable, that vessels passing near or over it might be enabled, by means of a detector on board, to discover that they were in its vicinity, and hence to locate their position. After satisfying himself with some experiments that the method was feasible, and that water offered no unsurmountable difficulty, and having been assured that no known instrument could detect the currents that could with present machinery be passed through a submarine cable, he had made further experiments, with the result that he had made two such instruments that would act through over 30 fathoms of water, and, without making any claim for novelty, he added that he had been unable to discover their like. He referred to previous experiments in the same direction, and then described the instruments which he had himself devised. The first of these was a coil of uninsulated copper wire rope, or other water connection, dipping into the water at the bow of a boat, and a similar water connection at the stern; if these were joined by a wire with a telephone on the circuit it would be found that a very sensitive instrument was produced, and that when the wire from bow to stern of the boat was at right angles, or nearly so, to a cable laid in the water, at some distance from it, the sounds produced by a magneto-electric machine connected to one pole of the machine were audible in the telephone.

Royal Institution. — The members of the Royal Institution listened to a very interesting lecture by Mr. Alexander Siemens last Friday on "Theory and Practice in Electrical Science." The title was evidently chosen to embrace both the suggestive experiments in high-tension work, as well as the very practical nail and rivet heaters that were shown in the theatre. The ordinary alternating current from the mains was used, and transformed up to some 50,000 volts in one transformer, and also down to 15 volts in another. The Norwegian iron trade requiring a furnace for the equal heating of the iron rods for the manufacture of horse-shoe nails, he had recently been asked to make, and had succeeded in making, an electrical heating furnace for this purpose. Diagrams were shown, and the furnace itself exhibited in action. It consists of a huge core of carbon rendered incandescent by the passage of a large current at low voltage; the core was embedded in sand to prevent escape of heat, and was itself hollow. An iron rod passed slowly through this became red-hot at once, the heat being regulated by the speed of pulling through. For tempering springs it has proved excellent, and the same kind of furnace was utilised for heating rivets. The advantages of portability and ease of manipulation were very evident. Mr. Siemens dealt with the use of electric motors in factories and towns, giving the instance of their own works, now entirely driven by electricity by means of Willans engines direct-coupled to Siemens dynamos. The saving of coal and labour was a great advantage, and the saving of the space, now utilised for other purposes, which the various engines and boilers used to take, was another noticeable commercial gain. Some highly interesting demonstrations of the phosphorescence of vacuum tubes and the huge octopus-like flashes across glass were also shown. There was an exhibition in an adjoining room of various electrical instruments, lamps, and apparatus from several makers.

Liverpool Overhead Railway.—On Saturday the Marquis of Salisbury, who had been the guest of Sir William Forwood since the previous evening, drove into Liverpool to inaugurate the overhead electric railway, the first of its kind in England as a street overhead line, and the first in the world as an overhead line propelled by electricity. On arriving at the generating station, his Lordship was presented with a massive silver inkstand, and, having touched a button, started the machinery; and in the course of a brief address said he was glad to be associated with an enterprise which he hoped would carry still further the prosperity and power of Liverpool, and carry its name down to posterity as the place where a great and splendid mechanical invention first found its home. His Lordship and party then went for a trip along the line, and afterwards drove to the Town Hall, where an address was presented to the noble Marquis from the Chamber of Commerce, welcoming him to the city, and thanking him for the courtesy and attention which the Chamber had always received from himself and his colleagues during their late Administration. Lord Salisbury, in his reply, dealt with fiscal and political matters. His Lordship was afterwards entertained at luncheon by the mayor. In replying to the toast of his health, he said the opening of the new railway was a matter of great interest to the citizens of Liverpool, and would probably conduce to the future prosperity of the city. It had introduced one of the most mysterious, most promising, and most powerful forces with which the age was acquainted to a new sphere of activity and energy. He believed electricity was destined to do enormous things, though as yet they could hardly entirely explain its most elementary phenomena. He was pleased to think that in the matter of electric railways England was not behindhand. In their progress along the new railway they had evidence of the adaptability of electricity to locomotion. It was true they were still behind some other nations in electric lighting, but that, he believed, was probably owing to a certain foolish Act of Parliament, and was now being rapidly altered.

Exhibition at Windsor.—The Windsor and Eton Scientific Society held a most interesting electrical exhibition at their *soirée* last week. The Windsor Electric Light Company supplied current free of charge, and many well-known firms sent exhibits, the show being kept open for three days. Mr. Roger Dawson had a pretty show of his artistic fittings, one of the most noticeable being an electrolier of the same pattern as supplied to the New Junior Constitutional Club in Piccadilly. Messrs. Paterson and Cooper had a large exhibit running the length of the room, showing their instruments and fine photographs of the *Daily Chronicle* installation. The details of the Hermite processes were also on view by this firm as used for the clarification of starch, bleaching of paper pulp, and disinfection of sewage, the particulars being explained by their engineer, Mr. E. G. Tidd. Perhaps one of the most generally interesting exhibits was the cookery apparatus shown by this firm, comprising flatirons, kettles, grills, and other heaters. On the opposite side of the hall was a very effective and well-arranged exhibit under the care of Mr. Dunning, of Windsor. Here were to be seen exhibits from the works of Messrs. Benham and Froud, of Chandos Metal Works, who showed several electroliers and brackets of beautiful and artistic design. The Walsall Company showed some of their measuring instruments; Messrs. Drake and Gorham showed a Cardew voltmeter connected up to show the pressure, a Cardew earthing device, ring contact switches, etc.; and Messrs. Laing, Wharton, and Down showed their automatic current regulator, by which all hand regulation is said to be abolished. The Electrical Company, Limited, of Charing Cross-road, showed domestic apparatus, as motors, cookers, and lamps. Of local exhibits, perhaps the one which caused the greatest interest was that of Mr. F. A. Rowill, of High-street, Eton, who showed a working model of a small gas-engine, made by him on the Crossley pattern, running a small dynamo, with accumulators, lamps, and motors—a complete model installation, contained on a table about 3ft. by 4ft. Mr. Warburton showed an electrical clock (lent by Lord Edward Churchill, chairman of the Windsor Company), also a stamping arrangement by which an ordinary rubber date-stamp is made to stamp the time automatically. There were also some of General Webber's pattern standards on view. Mr. Gillett, of Slough, showed a model of the land section of the London and Paris telephone, showing the twist given to the wires to prevent induction. He also showed a phonograph and sundry telephone apparatus. Mr. Fellows showed some vacuum tubes being rotated by an electromotor. The exhibition was much appreciated.

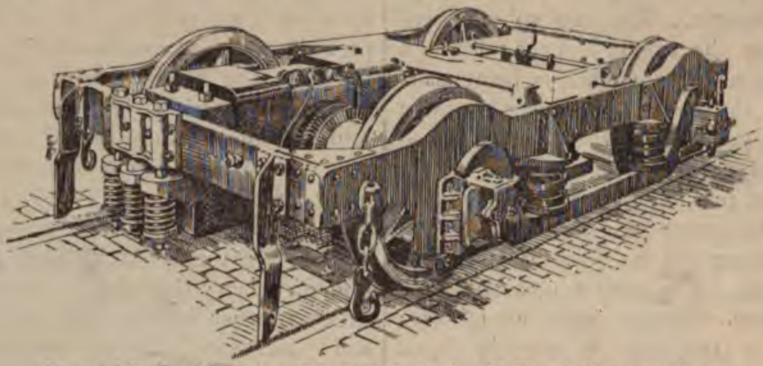
Electrical Waves.—At the meeting of the Société Française de Physique on the 6th ult., M. Guillaume presented, on the part of MM. Sarasin and De la Rive, a large photograph of their new apparatus for the study of electric waves in the air. In a first series of researches carried out in 1890, the authors showed that the internode or wave-length of oscillation observed along a pair of wires depends only on the resonator and not on the exciter, a phenomenon of which M. Poincaré has given the theory verified later by M. Bjerknes and M. Pérot. According to experiments which M. Sarasin has repeated before members at the central laboratory, MM. Sarasin and De la Rive showed, by small resonators, that the speed of propagation of electric waves is the same in the air as along wires. M. Blondinot has already shown the beautiful application he has made of this principle to the direct measurement of this speed. But for long waves the equality of speeds has remained without experimental demonstration, the experiments of Hertz on this point not being sufficiently clear, and, indeed, had led their author to believe in the possibility of a different speed. The narrow dimensions of the Hertz's reflector and the first reflector used by Sarasin and De la Rive did not allow of more than one node, using a reflector with circles of more than 50cm. diameter. After having extended their laboratory, the authors found their first results confirmed, but only obtained moderate sharpness in the phenomena; they therefore decided to work on a still larger scale, and set up in the building of the Geneva Waterworks a zinc reflector of eight metres by 16 metres; on a perpendicular raised to its centre, and at 15 metres distance, was placed the exciter, whose large spheres were 0 3 metre diameter. The small spheres were immersed in oil. Between the exciter and the reflector a funnel was mounted to permit of observations being made in the dark, as before; the observations were made by measuring, for a series of points between the exciter and reflector, the explosive distance on an interruption of the resonator; these distances, plotted as ordinates (the line joining the exciter to the centre of reflector being the abscissa), form an undulating line on which it is easy to measure the wave-length. The results obtained with circles of 50cm. and 75cm. diameter were as follows: "The wave-length of a resonator is sensibly equal to eight times its diameter. In the case of normal reflection, the first node is exactly at the reflector. The speed of propagation in air is the same as along wires." This experiment, carried out under such perfect conditions, is identical in principle with the beautiful experiment of Lippmann on the photography of colours. The air in front of the reflector is the seat of movements analogous to those which in the film of collodion determine the formation of layers giving rise to the perception of colours. Pursuing the analogy, M. Guillaume thinks that a series of semi-transparent mirrors (metallic-woven fabric or wetted cloths) arranged parallel to the reflector at equal distances, would give, by reflection, as in M. Lippmann's films, perfectly pure waves. The comparison of these waves with those of the exciter would show the degree of purity of the latter.

Goebel's Incandescent Lamp.—We had but time last week to give the bare statement of the fact that on the application of the General Electric Company of America on Edison's patent for an injunction against the Beacon Company of Boston, affidavits were produced showing that the whole invention—bulb, vacuum, bamboo filament, carbon, cement, and platinum wires—had been carried out as far back as 1859 by an old German mechanic of the name of Heinrich Goebel, in New York, and that incandescent lamps were publicly exhibited by him for many years prior to Edison's invention. This unlooked-for production of evidence took the Edison side completely by surprise, and though doubt was thrown on the subject, the injunction was not granted. The evidence of Heinrich Goebel himself, his sons, daughters, and some score or so of the neighbours, and of Mr. Franklin L. Pope were given; and on January 23 these affidavits were read and considered. We abstract the affidavits as follows, taking the report by long-distance telephone given in the New York *Electrical Engineer* for January 25: The affidavit of Henrich Goebel states he is 74 years of age, is an optician, born in Germany; knew one Prof. Moenighausen, who often talked to him of the possibility of using carbon conductor in a vacuum. Came to New York in 1848, and in the early fifties carried out these ideas: made lamps of glass tubing, with filaments of carbonised bamboo, and also of tampico; these were attached to wires of platinum, iron or copper, sealed airtight into the tube by fusion, the air was exhausted by means of filling with mercury, and the lamp was sealed off by fusion. From as early as 1855 to after 1881 frequently made such lamps, lighted his shop with them with the aid of a battery of 30 zinc-carbon cells; in 1859 and 1860 exhibited in various places in New York a large telescope fitted with two or three of these lamps and a large battery to attract attention: these lamps were seen by a large number of persons who well remember them. Some of these lamps have been preserved and accompany the affidavit. John C. Goebel, son of the above, states he remembers distinctly these lamps, which his father used to make in quantities, prior to 1872; some had burners like a fiddle-bow, others like a hairpin, and others formed a spiral: all were small in cross-section; remembers seeing his father make the spiral carbon by winding a very thin piece of wood round a cylinder, packing it in a crucible, and putting the crucible in the fire; the carbonising was done in a range in the basement; particularly remembers the use of black-lead crucible because wondered why "lead" did not melt: the wires were generally platinum, sometimes other metals; bought clippings of platinum for this purpose because they were cheap; remembers his father said there was no air in the lamps; had exhibited the lamps himself. Henry Goebel, jun., another son, states he remembers his father working the lamps, particularly "hairpin" and "meat-saw" lamps; accompanied his father when exhibiting lamps prior to 1872; remembers his father thrashed him for breaking a lamp. All the lamps had a tube entirely of glass, the wires passed directly through without solder, the glass was fused round them and fastened to the ends of two wires or ribbons, generally by stove-blacking; his father had a clock fixed so that the lamp lighted when the clock struck: this was before and after 1872. Horace van Ranst, a policeman, remembered the lamps and the sensation they caused; was frequently in Goebel's shop. Mr. Franklin L. Pope made affidavit that he had examined the three lamps said to have been made by Goebel: neither of them is in a condition to be operated, but is satisfied that when made they were capable of being operated, and had been operated; each originally consisted of a sealed glass chamber, in which was a carbon filament attached to metallic wires, which pass through and are sealed into the glass; the light-giving portion is $1\frac{1}{16}$in. long by eight to ten one-thousandths of an inch thick; it is secured to the wires by indurated carbonaceous cement, is made of carbonised woody fibre of endogenous growth, probably bamboo; the chamber is cracked and there is no vacuum now, but that there has been a vacuum is proved by indentations made by the air when the glass was soft, and, furthermore, by the smoky discolouration on the inside of the glass; is of opinion these structures embody the second claim of Edison; the making of them involved the knowledge of the fact that a filamentary carbon would stand high incandescence in a nearly perfect vacuum. Prof. Chas. R. Cross, of Massachusetts Institute, testified to the same effect, and states that the cross-section of the Goebel filament of lamp No. 3 was less than half that of the model accompanying Edison's patent. George G. Crosby, one time general manager of the American Electric Light Company, stated he had met Goebel in 1881, was surprised at his knowledge, as he had made lamps far superior to those of the company; afterwards employed him. Mrs. Nicholas Finck stated she was married in 1858, and before the birth of her son in 1860 was with her husband in Goebel's place and saw the lamps; the light-giving part looked like a very fine wire white hot, straight, and not thicker than a thread; told Mr. Goebel it was a beautiful light, and he ought to get rich by it. Many other witnesses testified to the same effect, to their knowledge of Goebel and his good character. Heinrich Goebel, we learn from Mr. Pope, has always lived in an obscure neighbourhood, speaks and understands English with some difficulty, and can scarcely read it at all. Though seventy-four, he is erect and bright; and few can even now excel him in experimental skill.

THE LIVERPOOL OVERHEAD RAILWAY.

(Concluded from page 128.)

In concluding the notices of this important and interesting development in recent electrical work, some particulars may first be given of the electric motors and conductor system already mentioned, but in brief allusion only, when dealing with the superstructure of this line and the rolling-stock that is employed on it for passenger service exclusively. As already stated, each train—composed of two individual cars—is provided with two electric motors, one at each end, with its armature mounted directly upon one axle of the bogie truck at that end of the carriage. The general arrangement of this may be seen from the accompanying illustration, which shows the motor in position upon the truck. The motors are series wound, of the solid double-pole type, with four field-magnet coils—machines now becoming well known both as generators and motors for tramway work in connection with the makers, the Electric Construction Corporation, Limited

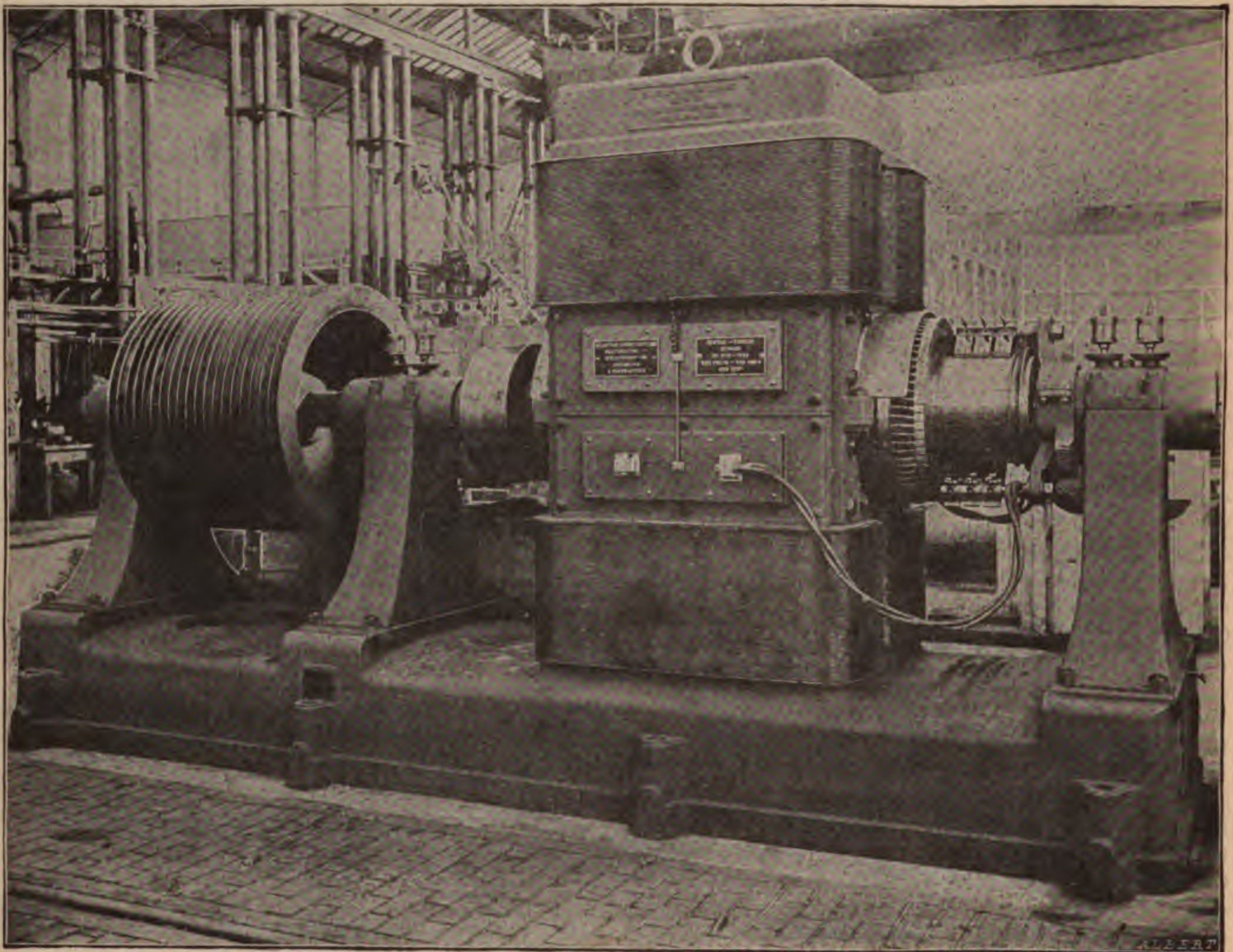


Liverpool Overhead Railway.—View of Bogie Truck, with Electric Motor attached.

The method of suspending each motor may be clearly seen from the engraving, which shows also part of the underframe, with three lugs or extension pieces. Through holes in these lugs are passed long bolts, secured firmly above to a plate casting bolted to the end beam of bogie truck, very powerful springs of a spiral type being slipped upon the bolts under the lugs, and thus carrying the weight of the motor at one end with great flexibility. The other end of the motor frame is hung from one side of the centre beam of the bogie truck in a somewhat similar fashion.

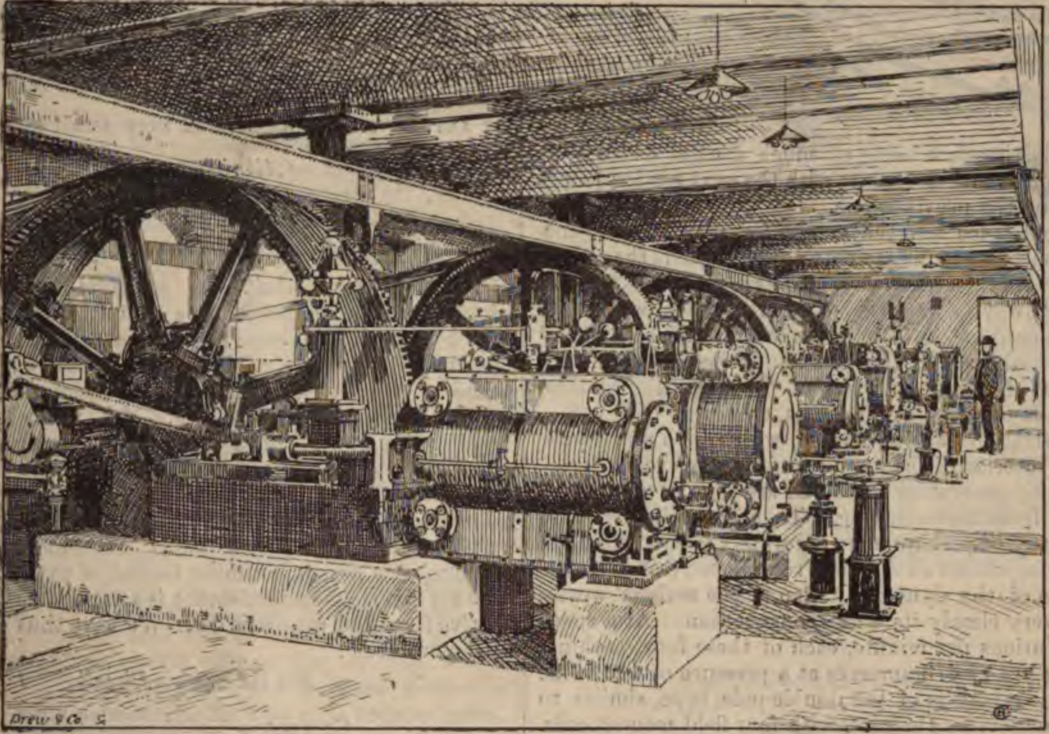
Tests of the motors with a brake, at the makers' works, have given the following results as the torque effort on the rim of the wheels (which, as already stated, are 2ft. 9in. diameter) when at rest:

30 amperes current	170lb.
40 ,, ,, ...	300lb.
50 ,, ,, ...	450lb.
60 ,, ,, ...	650lb.
80 ,, ,, ...	1,060lb.

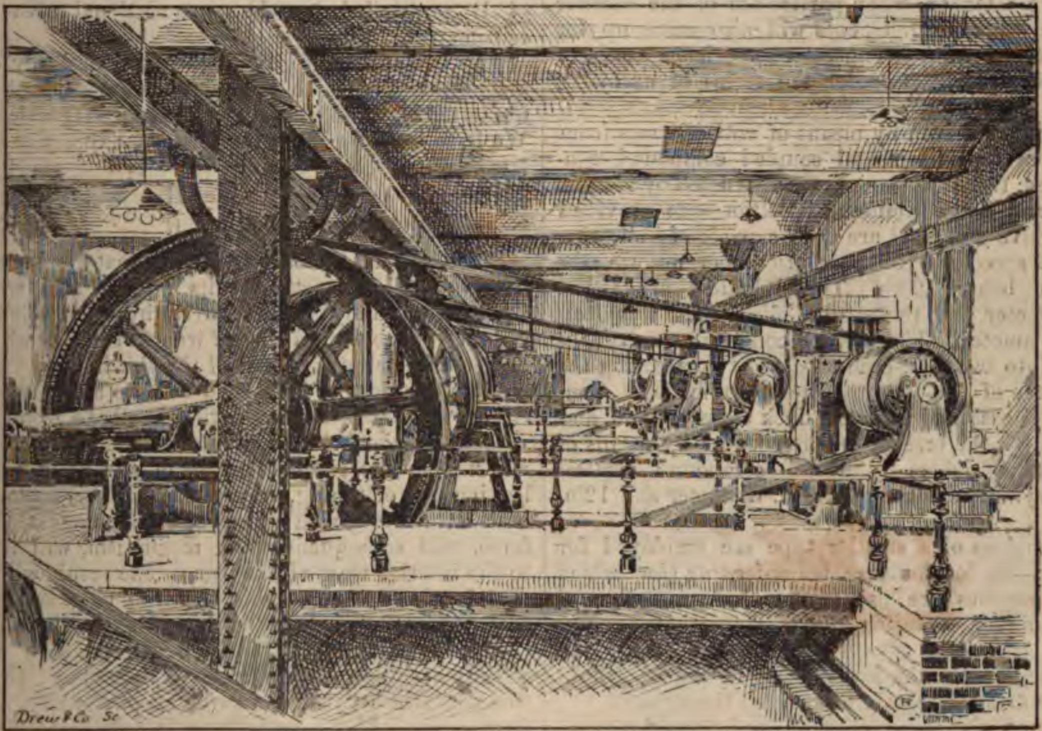


Liverpool Overhead Railway.—View of Dynamo Generator at the Makers' Works.

The current required to drive these motors is picked up from the line, as the train passes along, by a very simple arrangement which was illustrated in last week's issue. At one end of the bogie truck is bolted a plate with angles projecting downwards, to which is fastened a plain iron frame, capable of swivelling if necessary. Through the bottom of this frame — a few inches above the level of the line conductor—is secured a stout pin on which swing two dished iron plates. These bear upon the line conductor, and serve to collect the current from it with little loss by sparking and resistance. As the iron shoe-plate wears through, it is easily replaced in a few minutes, the expense of new castings for the purpose being probably not more than a shilling or two.

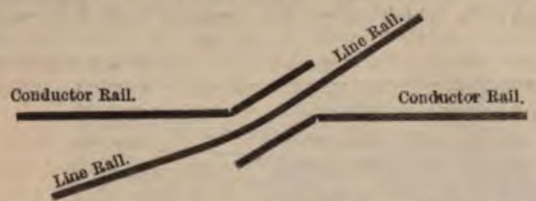


Liverpool Overhead Railway.—View of Engines at Generating Station.



Liverpool Overhead Railway.—View of Engine Room at Generating Station, showing Dynamos, etc.

The line conductor consists simply of inverted channel steel of ⊓ section, upon the top of which the iron collectors may slide. It is, of course, set parallel with and between the line rails, which form the return circuit from motors to generating station. The conductor is mounted throughout on porcelain insulators, which in their turn are supported by cross timbers let into the longitudinal line rail timbers, and its top surface is about $\frac{7}{8}$in. higher than the ordinary level of the line rails. At every other one of the 14 stations along the line there is a crossover road, whilst double crossovers are furnished at the termini to save shunting. At these crossings the conductor has, of course, to be broken in order to allow the ordinary rails to cross it; but no actual break of contact occurs, as the steel channelling is bent parallel with the ordinary line rail for some distance—in fact, so as to overlap somewhat thus:



and the collecting-shoe being of much greater width than the conductor, it makes contact with the next section before breaking it on the previous one.

The current is led into the conductor rails from a generating station placed almost centrally as regards the length of the line. At this point are situated, quite close to the overhead railway, a number of arches, upon which are lines of rails used for the Lancashire and Yorkshire Railway Company's coal-carrying business, and these arches have been utilised for the purposes of a generating station, containing the usual boilers, engines, dynamos, etc.

Two illustrations are appended, which give representations of the interior of the engine and dynamo room.

The dynamo-generators employed are four in number, as will be seen from the engraving. Their general appearance and design may be perhaps more accurately gauged from the large engraving shown also. This is reproduced from a photograph of one of the dynamos taken at the makers' works, and shows very clearly its solid construction. At a speed of 400 revolutions per minute, each of these four machines yields an output of 475 amperes at a pressure of 400 volts. The magnetic circuit is of the double-pole type, similar to that of the motors on the cars, with four field magnet coils. The poles are divided horizontally, so that the top half may readily be unbolted and lifted off at any time if it is required to examine or take out the armature. The latter process is also rendered the more easy by insertion of a coupling between the armature shaft and an extension of it which is used as the pulley shaft. The pulley is of large diameter, and grooved to carry 19 1¼in. cotton ropes; it is carried between two bearings, as shown in the engraving. Details of the switchboard and regulating devices may perhaps merit separate notice later on, when particulars of the electric automatic signalling arrangements will also come up for description, after a somewhat greater experience has been obtained of its capabilities under the stress of everyday wear and tear.

The dynamos are driven by means of cotton ropes from the flywheels of four horizontal coupled compound condensing engines; these fine engines—constructed by Messrs. J. Musgrave and Sons, Limited, of Bolton—are provided with Corliss valve gear, and are each capable of indicating 400 h.p. at a speed of 100 revolutions per minute, the boiler pressure being 120lb. The cylinders are 15½in. and 31in. diameter and the stroke 36in. The flywheels are 14ft. in diameter. The surface condensing apparatus is divided up into two sets, each capable of condensing the steam from three of the engines when fully loaded. Condensing water is obtained from the dock close at hand, and circulated through the brass condenser tubes by means of centrifugal pumps driven by small compound vertical engines, with cylinders 7½in. and 15in. diameter and 12in. stroke.

Five other engines of a smaller type are employed for minor services—as for instance, boiler-feeding (for which two separate engines are used, either being capable of feeding four boilers), operating the mechanical stoker and coal conveyor (requiring about 10 h.p.), and, finally, for working the scrapers on the fuel economiser pipes. Duplicate steam-pipe arrangements are provided throughout.

The boilers are six in number, of the Lancashire type, measuring 30ft. long by 8ft. diameter, and designed for a working pressure of 120lb. to the square inch. They are fed by means of mechanical stokers of the Vicars type, the coal being brought into overhead hoppers by means of a conveyor. The waste gases from the boiler flues are led, before passing into the smoke-stack, into a chamber containing one of Green's economisers with a range of some 400 pipes, through which the feed-water passes. The contractors have great hopes of working the line on a five-minute service with an expenditure of not more than 7lb. of coal per train mile. If this result be achieved, the congratulations already poured upon them for the sound work and excellent design of the overhead railway and its equipment will require to be renewed.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 97.)

The Magnetic Circuit.—In expounding the electrical circuit we had recourse to a water analogy. Here, in expounding the magnetic circuit, we shall have recourse to the analogy of the electric circuit. That which tends to cause a flow of magnetic lines of force is named the magneto-motive force, even as E.M.F. tends to move electricity; this flow of lines is named the magnetic flux, and so corresponds to the current in the electric circuit. The obstruction that is offered to this flow of lines is named the magnetic resistance, and so has its analogue in resistance of the electric circuit. The fundamental law of the magnetic circuit is similar to that of the electric circuit, because the magnetic resistance is a ratio between magneto-motive force and magnetic flux. We have thus the following analogous laws:

For the Electric Circuit.

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance}}$$

For the Magnetic Circuit.

$$\text{Magnetic flux} = \frac{\text{Magneto-motive force}}{\text{Magnetic resistance}}.$$

Magnetic induction, denoted by the letter B, signifies the number of lines per square centimetre, and the total induction, or the magnetic flux, denoted by the letter N, signifies the total number of lines, or the value of B multiplied by the cross-sectional area in square centimetres:

The magnetising force, or, as it is technically called, the magneto-motive force, is denoted, as mentioned before, by the letter H, while we may write R for magnetic resistance. We have thus the following formula, expressive of the first law of the magnetic circuit:

$$N = \frac{H}{R}.$$

Since iron is the only substance that conducts magnetic lines well, all magnetic circuits may be said to consist of air, iron, or partly air and partly iron. A solenoid is an instance of the first, a ring of iron of the second, and a bar or horseshoe electromagnet of the third.

Magnetic lines of force tend to take a somewhat circular course, so that if the magnetising coils be wound so as to make a circular helix or circular solenoid, most of the lines will flow in the circular hollow of the helix, scarcely any leaking out or taking stray paths. If this hollow be filled with iron, thus giving a circular electromagnet, the lines of force, and consequently the magnetism, will be confined to the interior mass of the iron. The result will be rather peculiar, for owing to this, the iron ring is useless as a magnet—no magnetism being evident. But cut through the ring, breaking the metallic circuit, here we get an air-gap across which the lines of force flow; therefore, in this air-space between the two ends of the ring, a magnetic field exists and its magnetism is available. On account of this air-gap, lines will leak out or curve out of the direct path which they would have taken had no gap existed, and the wider this gap is the greater is this leakage. Also, the more the circuit departs from the circular form, the greater is the leakage. In a circuit—say, of a rectangular form—where right-angled corners exist, the leakage is very high, the lines leaking out into the air in dense bunches near the corners. All corners and sharp angles should, therefore, be avoided in magnetic circuits, for their presence is as detrimental as bad insulation is in an electrical circuit. In dealing with magnetic questions, the term "poles" is freely used, and remarks made respecting them are mostly confined to merely theoretical technicalities, which are seldom wanted in practical work. The poles of a magnet simply mean that part where the magnetic lines of force leave and that part where they enter the iron, the former being named the "north pole," and the latter the "south pole." The direction of flow of magnetic lines is determined by the direction of flow round the iron of the current which magnetises the iron. The direction of flow of current is arbitrarily fixed as before mentioned, consequently the direction of flow of magnetic lines must likewise be arbitrarily fixed; and whatever the direction of either may be, reversing the direction of current reverses the direction of the lines. Knowing the direction of current in the wire (from positive to negative terminal), the polarity of a magnet is easily found; for wind the wire round the iron in a direction going from right to left, or with the sun, or clockwise, beginning at the end nearest yourself and finishing at the far end, then, if the current enters at the near end, and leaves at the far end, so as to circulate round the iron in the way a right-hand corkscrew would work into a cork, this far end where the current leaves the helix, or the end towards which the corkscrew would travel, would be the north pole, and the near end, where the current enters, would be the south pole, because the direction of flow of magnetic lines of force would be along the iron from the near end to the far end. In the case of a complete iron circuit, like a ring of iron, there are no poles, because no lines of force emanate from the iron; if the circuit be broken, the two ends become poles.

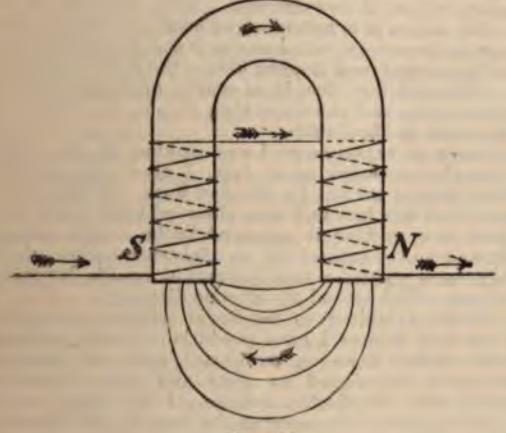

FIG. 15.

A straight bar electromagnet has its poles at its two ends; if the bar be divided into two, at the place of division two more poles will appear, and as the lines leave one end to enter the other end in flowing across the air-gap, therefore, at any break or discontinuity of the iron, a north and a south pole would appear, and however many times the magnet may be divided up, each piece will yield two poles.

The permeability of air remains constant at unity, irrespective of the intensity of the magnetic induction, which is very different from the great fluctuations of the permeability of iron, and owing to the very high magnetic resistance which air offers to the propagation of magnetism, the air-gap in a magnetic circuit is kept as small as possible; this air-gap contains the magnetic field, and in the magnetic circuit of a dynamo it is made as strong as possible, consistent with economical features, and its length limited, so that there is only just room enough to permit of the armature wires being rotated.

If a straight bar electromagnet be considered, its air return path from north pole to south pole is enormous in length, being much longer than the straight iron portion of the circuit. By bending the bar into a horseshoe shape, as shown in Fig. 15, its air path is considerably reduced; this is named a "horseshoe electromagnet," and is the outline of the general shape given to the magnetic circuit of a dynamo. It will be observed that the path taken by the lines across the short air-gap from one pole to the other is not straight, but curved, only a few lines flowing at right angles to the bar. The magnetising coil is shown circulating round the bar in a right-handed direction, beginning at the left leg, at which place the current is assumed to enter the coils; consequently, the far end, or right leg, is the north pole. The direction of flow of the magnetic lines is shown by the two arrows.

To concentrate the magnetic field between the two poles, masses of iron, called "pole-pieces," are attached, having their opposing faces curved so as to almost embrace a circle; this tends to direct the flow of lines more in a straight line from one pole-piece to the other. In this form the working of the iron would be very troublesome and therefore expensive, and, in addition, the coils could not very well be wound on the legs of the magnet. To obviate these drawbacks the magnet is usually made in three pieces, the bended part being replaced by a straight bar, called the "yoke," and screwed on to the two separate legs, or "limbs," each limb and pole-piece being made from one piece; it can now be understood where the advantage comes in by using cast iron in place of wrought iron, for the limb and pole-piece can be cast at once into the design required, and only require a little planing and machining up. The magnetising coils are carried on the limbs of the magnet; it is of the utmost importance that the yoke should be screwed on the limbs in such a way that a good and true metallic connection is made, because if the surfaces are not planed with great accuracy so as to get as many contact points as possible, the thin film of air between the surfaces will add greatly to the magnetic resistance of the circuit. This means that joints should be avoided, and limited to what is absolutely necessary for the economical turn out of the magnet. When wrought iron is used for the magnets, the pole-pieces are often made of cast iron, and then screwed on to the limbs of the magnet. This slightly lowers the magnetic flow, but the advantages of having pole-pieces cast into shape compensates. All corners should be curved down or cut off, otherwise great magnetic leakage will occur. It is very usual to have the yoke likewise made of cast iron. When this is so, the yoke is made larger in sectional area than what it would be if made of wrought iron. The magnetising coils can be wound by putting the magnet limbs in a lathe. When both are wound, the two coils are joined together. The winding takes place on a brass bobbin fixed on the magnet limb. Often, however, the wire is wound on the brass bobbin alone, and the latter slipped on to the limbs, which are then screwed into the yoke, the pole-pieces, if separate, being then attached. The modified arrangement is shown in Fig. 16, which may be taken as a good example of the field magnets of a dynamo, the type being after that used by Messrs. Siemens Bros. A dynamo made

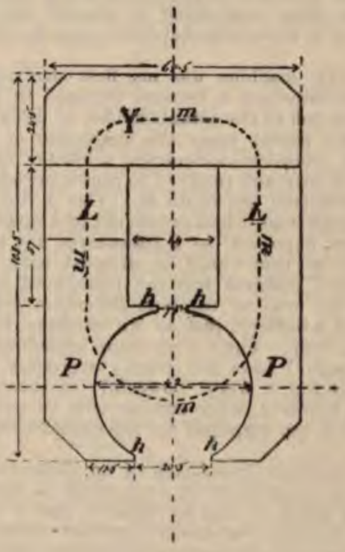

FIG. 16.

with this size field magnets would give an output of about 45,000 watts at a speed of 450 revolutions per minute, and be capable of maintaining 800 incandescent lamps of 16 c.p. each. The drawing is on a scale of $\frac{1}{10}$, the measurements given being in centimetres, the depth of the magnets being 48cm. The thick dotted line denoted by *m*, *m*, *m*, *m*, traces the magnetic circuit; Y denotes the yoke; L L denote the magnet limbs; P P denote the pole-pieces; *h*, *h*, *h*, *h*, denote the horns of the pole-pieces. The depth of winding on the limbs would be about 9·5cm.

(To be continued.)

THE NEWCASTLE LITERARY AND PHILOSOPHICAL SOCIETY.

The hundredth anniversary of the Literary and Philosophical Society of Newcastle-on-Tyne was celebrated by a *conversazione* in the rooms of the institution onTuesday. A large number of local notabilities were present, being received by Dr. Embleton, Dr. R. Spence Watson, and Mr. John Pattinson. The National Telephone Company had music laid on, and Dr. Watson read an interesting historical statement of the progress of the society.

Lord Armstrong lectured on "Electrical Phenomena." His Lordship said: The Literary and Philosophical Society was founded by a small number of literary and scientific men, of whom my father was one. For 30 years I have had the honour of being president, and as such it is fitting I should contribute in some way to the celebration. I have, therefore, undertaken to exhibit to you this evening some electrical experiments which possess sufficient novelty to render them interesting to experts and, at the same time, entertaining to those who have but scant knowledge of electrical science.

The hydro-electric machine was my first electrical love; but soon after its introduction I became engaged in the hydraulic experiments which led to the establishment of Elswick, and from that time to very recent years the exigencies of business prevented my giving attention to electrical subjects. But I remained faithful to my first love and resolved to renew my addresses if ever circumstances permitted me to do so. This I did about a year ago, but in the meantime, I had grown old and unable to bear the necessary outdoor exposure, so I transferred my affections to a less exacting mistress that would be satisfied with indoor attentions. That second mistress was the Rhumkorff induction coil. My first endeavour was to combine induction coils in such a manner as to form a battery, just as we combine Leyden jars or voltaic cells in battery. There were many impediments to doing this, and, although I have not wholly overcome them, I have succeeded, in making a very powerful apparatus upon this principle, which, however, is too cumbersome to be brought here this evening, and is not required for the experiments I intend to show you.

I have a large diagram illustrative of an induction coil. I am doubtful as to the expediency of explaining it, because to do so will be deemed a waste of time by experts, and a bore by those who are wholly ignorant of electricity, but there is an intermediate class to whom a popular explanation may be welcome, and for their sake I will endeavour to make the subject intelligible in as few words as possible.

His Lordship here described the induction coil, and then proceeded as follows: Now I daresay many of you will be tired of talk, and more anxious to see than to hear. I will therefore first show you the spark from the induction coil on the table, which is a very powerful one, made by Apps. The short spark with which I commence consists entirely of flame, which Mr. Crookes has shown to be due to the combustion of the nitrogen of the air in its union with the oxygen to form nitric acid; then, as I gradually increase the separating distance, you will see a torrent of sparks passing between the terminals. I go on increasing up to 18in., when sparks still continue to pass, though in reduced numbers. I will next show you some other beautiful illuminating effects, and then proceed to things which, from their novelty, possess more scientific interest.

Probably many of you are aware that soon after I introduced my hydro-electric machine I designed and made a very large one for the Polytechnic Institution which then existed in London. It proved to be by far the most powerful instrument for the production of frictional electricity that had ever been seen. It was a very short time in my hands after its completion, and I made the best use of my time in trying experiments with it in the open air. Amongst other experiments I hit upon a very remarkable one. Taking two wine-glasses filled to the brim with chemically pure water, I connected the two glasses by a cotton thread coiled up in one glass, and having its shorter end dipped into the other glass. On turning on the current, the coiled thread was rapidly drawn out of the glass containing it, and the whole thread deposited in the other, leaving, for a few seconds, a rope of water suspended between the lips of the two glasses. This effect I attributed at the time to the existence of two water currents flowing in opposite directions, and representing opposite electric currents, of which the one flowed within the other and carried the cotton with it. It required the full power of the machine to produce this effect, but, unfortunately, when it went to London, and was fitted up in the lecture-room, I could not get the full power on account of the difficulty of effecting as good insulation in a room as in the outside air. I therefore failed in getting this result, after announcing that I could do it, and I daresay I got the credit of romancing. It has ever since been my desire to establish my veracity in this matter, and with the powerful apparatus now at my command, I speedily succeeded in reproducing the experiment in a modified form. In fact, I have done it in different forms; but the one which I shall show you this evening is as striking as any, and can be performed with the single induction coil which I have upon the table. The conditions of the experiment are as follows: I take a glass bulb having a long neck on one side and a short nozzle on the other, the nozzle having an aperture of one-tenth of an inch diameter. Through this aperture a string composed of spongy cotton thread is passed. The string is barely sufficiently thick to fill the aperture, and is secured at the upper end by a knot or by attachment to a conducting wire, which enters the bulb through a cork at the top of the neck. The bulb is then plunged into a glass cistern, and both bulb and cistern are filled with carefully distilled water, and the cork is tightly inserted in the neck. The whole is placed in the field of the lantern so as to be exhibited on the screen. And now, all being ready, we will send a positive current into the bulb, and make the cistern negative, and if I am not again sold, as I was at the Polytechnic, you will see the cotton climb up into the bulb. You see it is so, and now I reverse the current and it comes rapidly down. Those who are near will see that there is a clear indication of water rushing out of the aperture all round the cotton. The water in passing the aperture becomes a little heated, and is rendered visible by a flicker, just as hot air becomes visible when it mingles with cold. But the bulb remains full, and if water comes out without lessening the quantity in the bulb, an equivalent quantity must be going in by the same aperture, and as the descending column visibly flows outside of the cotton the ascending current must flow inside the cotton, and must carry the cotton with it. The two currents become distinctly visible when the cotton is removed, and though we cannot discern their relative position until they are clear of the aperture, the facts of the case seem to demonstrate that the negative current flows inside of the positive and determines the direction in which the cotton travels. This conclusion appears to me a very interesting one, and may tend to elucidate the relationship between positive and negative currents. When the cork is omitted the level of the water in the bulb is free to rise or fall, but it remains stationary under the compensating action of two currents. This, however, is not the case when the cotton is in operation without the cork, because the cotton impedes the current which moves it and gives the ascendancy to the outside current, and thereby lowers the level of the water in the bulb. The contrary effect is, of course, produced by reversing the electric current, and the water then rises in the bulb above the level of the water in the cistern.

In the course of experiments I was making on the dispersive effect of the electric spark upon dust, I observed that the disturbed dust always settled in circular lines. Although I afterwards found that this fact had been observed before, yet to me it was perfectly new, and, as it appeared to be a very interesting fact, I followed up the subject by an elaborate course of experiments which have yielded a rich harvest of results, revealing the hidden motions which attend the electric discharge.

I have already exhibited to the Royal Society photographs of many of the dust figures I have produced. Those photographs were of dust figures done on cardboard, and the photographs were afterwards transferred to glass and were shown at the Royal Society with the electric lantern. I will show you a few of these photographs this evening by way of introducing the subject, after which you shall see a selection of figures, in actual process of formation, on the horizontal stage of a limelight lantern. In all these figures I shall use plates of glass with a layer of fine dust sifted over them, and shall operate upon the dust by a spark discharge acting in various ways. I use three kinds of dust—calcined magnesia mixed with charcoal in the form of lampblack, tripoli powder, and hard carbon reduced to a fine powder. These three varieties act somewhat differently, and each kind has its application in the production of the best effects. The dust is sifted upon the plates in an evenly distributed layer, and the effects are shown by the manner in which the dust is displaced by the electrical disturbances.

You are all aware that when a gap is made in a conducting wire and a spark passes between the several points, all that can be seen is a streak of fire; but if I lay the severed wires upon the surface of a dust-plate we get the figure which I will now show you by a photographic plate inserted in the lantern. You see the dust is brushed away from the track of the spark, but the action takes place sideways and not in the direction of the spark. You also see that the discharge takes place not merely from point to point of the wires, but also from the sides of both the positive and negative wires, as indicated by beautifully regular streaks in the dust—the stronger ones being positive and the weaker ones negative. You will also see that there are circular lines faintly visible outside of the central figure, but when a Leyden jar is used as a condenser to give density to the spark, these circular lines come out very strongly, but as I shall presently show you their actual formation, I need not show the photograph. But these circular lines are also produced by a vertical discharge through a hole in the glass, and as it is not easy to do this on the stage of the lantern without piercing the lens, you must be content to see the photograph, which shows the circular lines very distinctly. Another figure involving the same difficulty must also be shown by photograph. It exhibits a dust-plate with six small glass pillars erected upon it to obstruct the motion of the dust. You see the lines are now diverted from the circular form and thrown into arches from pillar to pillar, while the spandrels are filled with inverted curves. You will also see that the ends of the arched lines cling to the glass pillars, notwithstanding the outward drift of air, thereby indicating a strong attraction between the dust and the pillars. I will now dismiss the photographs and proceed to show you the formation of the figures upon the horizontal stage of the lantern, and this a thing which has not yet been exhibited in public. I will begin with an experiment in which the dust is thrown into circular lines by an electric discharge from a Leyden jar, passing between wires parallel with the surface of the dust, and sufficiently raised above the surface to avoid the sweeping action of the air blast, and I expect you will see the movement in great perfection on the screen. You observe that the dust is thrown into circular lines up to the very centre, and a close inspection also shows a very active reciprocal motion amongst the dust particles themselves, which seem to indicate a transmission of electricity by convection. I will now take another dust-plate, and raise the sparking points to such a height as will save the dust from any disturbance by the discharge. You shall see the dust-plate first, and notice that the spark has no effect upon the dust; but I will now place upon this dust-plate a piece of sheet lead cut into the form of a cross, and supported on four needle points at a distance of one-tenth of an inch above the dust. You would naturally expect that this sheet lead, acting as a shield, would give to the underlying dust additional security against disturbance. But now, after passing a few sparks without effecting any disturbance of the exposed part of the dust, I lift the cross, and you see that the shielded part of the dust is thrown into beautiful symmetrical curves depicting the figure of a cross.

We may go a long way towards an explanation of these curious effects by saying that the particles of dust are polarised, and separated into wave lines by atmospheric vibrations; but this explanation fails to meet all the facts of the case, and for the present I must be content to show you the results without attempting to fully explain them.

I will now discard the Leyden jar and bring the wires down until they lie upon the dust-plate, and will take very gentle sparks direct from the coil. On doing so, you see the track of the spark and the off-shoots from the wires. You will also observe that the off-shoots from the positive wire bend round the spark track to get at the negative, while the negative off-shoots seem to make no effort to get round by the outside to the positive. I am therefore led to believe that the negative current follows the inner course, and the positive the outer one, and this is in unison with the cotton experiment, which presented every appearance of an internal and an external current, the inner being the negative current and the one which carried forward the cotton. And now you shall see a very beautiful figure, caused by splitting the positive current and bringing it up to the sparking points in two lines, curved in a manner to show how the dust streaks behave towards each other. The field is not large enough to show the whole figure at once, but by moving the dust-plate you shall see it all in parts. There is the figure, and you see a very marked distinction between the inside streaks and the outside ones, which is explained by the fact that the insides face and oppose one another. You see also various dark spaces which show absence of disturbing action, and there is a very peculiar dark band running parallel with the wires, which may be due to a jumping motion from the surface of the plate. You would hardly expect to see such a revelation where nothing was to be seen before but a tiny spark. But we will now banish this spark to a distance and operate upon the dust with the electric emanations from the wires alone, or from metallic terminals in contact with them. The positive and negative wire will then be mere branches from the main circuit, and the spark will take place on the main line and not between the branch terminals. In the first place, I will draw down the point of the positive branch vertically so as to touch the centre of a dust-plate. There is a lead ring serrated on the inner edge surrounding the dust-plate to which the negative branch may be attached, although it does not make any difference beyond exalting the effect, whether I attach it or not. When I turn on the current you see that a circular figure is established on the plate showing radiations which represent the transverse view of what you have seen before. It is probable that self-induction is the operative principle in the production of this sparkless figure; but I observe that whenever electricians are at a loss for an explanation, they mystify their hearers by attributing the effect to self-induction, and I find it convenient to follow the practice in this instance. You will perceive a slight negative effect proceeding from the ring, but I now reverse the current, and you then see a splendid display of streamers pouring inwards from the circumference to the centre. A still more beautiful effect will be displayed in the next figure, in which the central part of the plate is occupied by a slender cross of sheet lead pointed at the tips. The influence of the points in the formation of this beautiful figure is very conspicuous. Another variety of figure equally beautiful is shown by placing on the dust-plate a strip of sheet lead, saw-shaped on both sides. In the last three experiments I have used tripoli dust, which is a very imperfect conductor, and has a slight adhesiveness to glass, which makes it show the pencillings more distinctly. But I will now use carbon dust, which is a good conductor, and you will find quite a new effect is produced.

I shall use no spark on the dust-plate, and operate with branch wires from the circuit as before. In the first place, I shall bend down the negative branch perpendicularly, and cause it to touch the dust-plate in the centre, and I shall apply the positive branch to the lead serrated ring which surrounds the dust-plate. You see the dust rolls up in massive circular waves from the circumference to the centre, followed by beautiful streamers from the surrounding points, and altogether presenting a most extraordinary figure, and one of great beauty. I will next put the four-pointed star already used in the centre, and proceed the same as in the preceding experiment. You see a figure widely different from the last, and not less beautiful. These dust figures may be multiplied in endless variety; but time will only permit of my showing you one more. I substituted for the four-pointed star a lengthened piece of lead, with parallel serrations on the two sides, and I take away the lead ring, together with the positive branch wire attached to it, and I place the negative wire in contact with the piece of lead now placed in the centre. As I have removed the positive wire, you will observe that the negative terminal acts without any opposite positive terminal, yet you will see that a figure is produced involving forms and motions which words can hardly describe, but, like all the others, distinguished by symmetry and beauty.

And now I have only one more remark to make. There will be some amongst you who will ask what use are such experiments as these? I answer that the more we pry into the mysteries of electricity the more we shall be able to apply it to the service of mankind; but, apart from that consideration, knowledge for knowledge sake is a worthy object of pursuit.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 9.

Mr. W. H. PREECE, F.R.S., President, in the chair.

The following is the list of members balloted for and elected:

Members.—Prof. Robert Henry Smith, Mason College, Birmingham; Gerald Stoney, B.A., Heaton Works, Newcastle-on-Tyne; Everden James Wimshurst, 20, South-street, Huddersfield.

Associates.—Hans Hamilton Bens, B.A., 34, Cadogan-terrace, S.W.; Arthur B. Chatwood, the British Post Office, Constantinople; William Havilland Druce, Victoria-park, Dover; William Martin Evans, the Post Office, Repeater Station, North Walsham; Henry Farmer, Colville House, Beckenham, Kent; Frederic James Madgen, 335, Milkwood-road, Herne Hill, S.E.; Noel Francis Nalder, 94, St. George's-square, London, S.W.; James Pigg, 37, Union-terrace, York; Arthur E. Pond, 12, Cleveland-terrace, Seaford-road, Stamford Hill; James Roberts, M.A., LL.B., 52, Burlington-road, W.; Keith Robinson, 54, Boundary-road, N.W.; Leigh Robinson, 54, Boundary-road, N.W.

Students.—William Cotsworth, 42, Trinity-square, S.E.; William Richard Thomas Cottrell, 25, Connaught-road, Harlesden, N.W.; John R. Dick, Central Institution, Exhibition-road, S.W.; Richard Thomas Durran, 39, Bridge-avenue, Hammersmith, W.; Allan Bertram Field, "Claremont," Woodberry Down, Finsbury Park, N.; Edward Graham Fleming, Wych Elm Lodge, South Dulwich, S.E.; Andrew Gray, Carisbrooke, Helensburgh; E. E. Gunter, 9, Gwendwr-road, West Kensington, London, W.; Joseph Renwick Hewitson, 40, Rectory-place, Woolwich, S.E.; Thomas Richard Kenny, 18, Culford-road, London, N.; John Peacock Mackenzie, Faraday House, Charing Cross-road, London, W.C.; James Henry Millen, 68, Brunswick-place, City-road, E.C.; Wilfred John Previté Orton, Faraday House, Charing Cross-road, W.C.; George Herbert Oswald, Messrs. Siemens Bros. and Co., Woolwich; Hastings Victor Sadler, 42, Trinity-square, London, S.E.; Phillip J. Sageman, 25, Huntley-street, London, W.C.; Charles Davis Taite, Faraday House, Charing Cross-road, W.C.; William Henry Wilding, 28, Walham-grove, London, S.W.; Wm. Heselton Wraith, Northfield, St. John's, Wakefield.

The **President** announced that Sir D. Salomons had presented £500 to be added to the Salomons Fund, also £20 to the Benevolent Fund.

Prof. Ayrton, in continuing the discussion on Prof. Fleming's paper, referring to electrostatic voltmeters, said he and Mr. Mather would shortly read a paper on the design of these instruments of accuracy to one-tenth per cent., using circular needles.

Dr. Fleming made a long, exhaustive, and interesting reply to his critics—too long to summarise fully here. He traversed Mr. Swinburne's objections, and showed that he endorsed on December 1st what he repudiated on December 16; hoped Mr. Swinburne would adopt the mica coating to enable his meters to read to 4,000 volts; agreed with Dr. Sumpner's explanation; maintained that the facts showed the best open-circuit transformer produced is not better than closed circuit. In an extremely suggestive set of tables specially prepared as "energy balance sheets," he compared the losses of Hedgehog and Mordey transformers, adding the energy going in and coming out at 0, one-tenth, one-eighth, one-quarter, and three-quarter load, showing both gave all-day efficiency, on 10 per cent. load factor, of 79 per cent. Further calculating all day losses in cable of four transformers at end of a mile, $^{7}/_{16}$ cable, the Hedgehog lost 2·66 units and Morley only 0·438. Taking 2·2 units a day, we have 914 units per year at 3d., a loss of £11, capitalised at 10 per cent. £110, which would pay for a good many Hedgehogs; in fact, they could afford to throw them away and buy others. He advised Mr. Swinburne to go back to Cromwell Varley's pattern of 1856, and interlock his hedgehog bristles outside in a closed circuit! He then went into the calculation of high and low pressure feeders at one mile, showing L.P. cost £1,000, and H.P. £500 for 24-kw. plant, while the maintenance cost would be, low pressure £111, and high pressure £96—that is, can be put down for half and maintained for less. The L.P. system would also require much larger generating plant. The relative loss also increases in the low pressure mains as the load factor increases. The direct current system was not efficient over one mile. He hoped the time of beliefs was now left for that of facts and exact calculations.

Mr. Mordey's paper will be given on 23rd inst.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NATIONAL TELEPHONE v. BAKER.

It is with some misgiving that we venture to comment upon the judgment in this case. We have no fault to find with the result: we agree that it is the only just conclusion to arrive at. The telephone company will probably appeal, because it is in the interests of the lawyers so to advise, but as regards any rights in the matter outside legal subtleties they have none. They never had; and the judge truly remarked that he held the plaintiffs could not maintain an action either for an injunction or for damages. For the moment let us leave the result and take a glance at industrial history. Less than twenty years ago the industrial world of electrical application was a very limited quantity. Telegraphy was the only one prominent factor, though electro-deposition was not altogether unknown. The later seventies saw an awakening and a development so great and so wonderful that history records nothing like it. The common conveyance of speech by electrical methods was then introduced. Graham Bell produced his wonderful apparatus. Hughes gave that which made the apparatus commercially practicable. America took up the new departure, and hastened to instal the telephone everywhere. England was coy—she usually is, except in finding money for insane suggestions. Telegraphy was in the hands of the Government, and the advisers of the Government made a fatal error in refusing to take up telephony. That mistake will yet cost us millions—and serve the nation right. Private adventure was allowed to exploit telephony in this country, and as soon as it was seen that it would be successful the Government claimed a royalty for infringement of prerogative. Of course the exploiters of the telephone have made much of this tax, and for long appealed to sentimentalism and ignorance as a hardly-used body. However, we hold that the Government officials have made almost every possible blunder that business men could make in regard to telephony, and have in the long run landed us into the hands of an irresponsible monopoly. The telephonists have continuously strengthened their position, and neglect no opportunity of ruining a possible rival. It is, we suppose, now admitted that the telephone company introduced the cheapest system that it could devise—one that by using the earth as a return meant interference whenever and wherever earth was used by other parties for electrical purposes. This policy on the part of the telephone company compels it, as a matter of life and death, to oppose anyone else using "earth." The telephone service is bad enough without any interference, but inductive action occurring makes the service intolerable. The telephone company knows its simple remedy is in metallic returns, but it prefers to attempt to stop all other electrical development rather than perfect its own system. Hence, when Mr. Graff Baker, after arduous negotiations with the Leeds Corporation, entered into an arrangement to run a portion of the tram system of the town electrically, the opposition of the telephone company was natural. It did not matter that this particular tram system had long been practically idle, and not of the great use to the population it was intended and could be made to be. That Mr. Graff Baker equipped the tram line on the Thomson-Houston overhead system is known to all our readers, and, as a result, the telephone company commenced an action against him. It is this action that has been decided and judgment given. Henceforth, tramway people will not have the fear of telephonic litigation threatening them and restraining development. If we were to examine the argument in Mr. Justice Kekewich's decision which refers to water analogy, it would need almost a volume to put it right. The direction in which water will go when escaping from a reservoir can be foretold, but the direction in which the current goes when earth is used as a return is not known and cannot be foretold. Mr. Preece's experiments have proved that inductive action is not a question of yards—hardly of miles; it may be felt with half the island intervening. Thus only as a vested interest could telephony hope to escape troubles. If being in possession gives the right to stop all interference, then the telephone company that holds the monopoly in England can stop every advance in which "earth" was adopted. The *Times* designates this decision as of "momentous importance." It is at once seen to be so far as the engineering part of electricity is concerned, but we think it will have far more important results upon the policy of the telephone company. An opposition telephone company has just been absorbed. That opposition was favourably received by the public because it promised a more perfect system and a better service. The promised "metallic return" system has also been in a measure adopted by the successful absorber, but little haste has been shown to give the public the benefit of that system. Perhaps this decision of Mr. Justice Kekewich will hasten the work, inasmuch as, when completed, some at least of the many complaints of users will be relegated to the past.

OBITUARY.

THE LATE MR. J. E. H. GORDON.

The late James Edward Henry Gordon, whose death through accident we sincerely regret to have to record, was born in 1852. His father was Dr. J. A. Gordon, F.R.S., physician to the London Hospital. Mr. Gordon was educated at Eton and Cambridge, with an interval between the two, which he spent at King's College, London, studying physics under Prof. W. G. Adams, F.R.S. While there he invented and brought out an electrical anemometer, which proved successful. He took a mathematical degree, and studied for a year or two in the physical laboratory under the late Prof. Clerk Maxwell. He afterwards set up a laboratory at his father's house at Dorking, where he carried out his researches on the electromagnetic rotation of polarised light, and on the specific inductive capacity of dielectrics, which were published in full in the *Philosophical Transactions* for 1877 and 1879. On his marriage in 1878, he accepted the appointment of assistant secretary to the British Association, which, however, he only held for two years. In 1880 he published the first edition of his work, "A Physical Treatise on Electricity and Magnetism," which has gone through three large editions in England, one in America, and one in France. In 1881 he was appointed one of the 31 English delegates to the Electrical Exhibition in Paris. Thenceforth he devoted himself more to the mechanical side of electrical engineering, and designed and constructed a dynamo which was exhibited in 1882 at the Telegraph Construction and Maintenance Company's Works at Greenwich. It was then the largest in existence, and attracted a good deal of attention. He also designed and patented numerous other electrical appliances. In 1884 he commenced the carrying out of the electric lighting of Paddington Station, which is still one of the largest installations in the world, containing, as it does, engines of nearly 2,000 h.p. In this work Mr. Gordon not only designed and carried out the electrical arrangements, but also the whole of the mechanical arrangements for a steam plant on a scale then unprecedented on land. This plant was successfully started on April 21, 1886, and has worked satisfactorily from that day to this, at a working cost considerably less than that of gas. The T. C. and M. Works decided not to go on with electric lighting work, and Mr. Gordon started the Whitehall Company, which was afterwards bought up by the Metropolitan Company, with the initiation of which Mr. Gordon was connected, and of which he was for a short time a director. Increase of consulting work was the reason given for severing his connection with the Metropolitan and commencing business for himself. The late Mr. Gordon was a gentleman by instinct as well as by education, position, and training. That being granted, it will easily be understood that he did not feel very happy with some men connected with the Metropolitan; in fact, he never hesitated in expressing his opinion of them. After severing his connection with the Metropolitan, he entered into partnership with Mr. W. J. Rivington, and commenced central-station work. The firm was afterwards formed into a company, and did a lot of work. Unless, however, we are misinformed, the work of the Sydenham-hill station was the cause of a lock-up of capital, and the company is now in a position of difficulty. It may be to the worries and troubles of business he owed his untimely death. At all times he was a bold and venturesome rider. On Friday last—perhaps to get rid of business cares—he went to get a horse from Mr. Barnes's, London-road, Thornton Heath. The horse ran away, and in attempting too short a turn fell with its rider. The injured man was taken at once to the Croydon General Hospital, but died immediately, the cause being an extensive fracture of the skull. Mr. Gordon was an old friend of ours, and he was always the same. It was during his secretaryship of the British Association that he decided to go in wholly for electrical engineering. It was then he was designing his big machine, which was afterwards tried, improved, and finally adopted for Paddington. From then to the time of his tragic death he has been one of the leading spirits in pushing electrical work.

THE LATE M. VAN RYSSELBERGHE.

The death on Friday last, at Antwerp, of this well-known Belgian electrician was announced. Van Rysselberghe was not only an electrician, but was familiar with other branches of scientific work. It was, however, through his connection with telephonic apparatus to be used over the same wires as the ordinary telegraphic apparatus that he was best known to the electrical world. For his varied scientific attainments he held a high position in the scientific world in Belgium, and his loss will be widely felt and deeply regretted.

Friction Gearing.—The wheel of the locomotive progresses by simple friction on the rail, then why cannot the electric motor drive the wheel by friction on its upper surface running at high speed? The difficulty is one of overcoming effect of vibration. A device has been perfected for Messrs. Siemens and Halske by two engineers, Philipsborn and Schiemann, of Berlin, for this purpose. Two huge springs take the weight of the car, and sliding bars allow the relative distance of motor and driving-wheel to remain the same, the motor driving the wheel by friction.

SPECIFIC WEIGHT OF PEROXIDE OF LEAD.

The particulars of the specific weight of the oxide of lead formed on accumulators will be useful in constructing these cells. Researches have been made by M. Kirchknopf on a considerable number of cylinders of peroxide detached from plates which have served for four years. The mass presents a crystalline structure. After having been washed several times in distilled water and dried, M. Kirchknopf finds the peroxide gives the following figures: Specific weight of the positive mass taken from a well-formed cell freshly charged, $V_1 = 7{\cdot}75$ without taking into account the pores; weight of the same mass, with the pores filled with air, $V_2 = 4{\cdot}66$. The weight per unit volume is what must be considered when calculating the mass of active material in a given space.

AN IDEAL CENTRAL POWER STATION.*

BY C. J. FIELD, E. J. COOK, AND F. BOURNE.

(Concluded from page 104.)

Fittings.—Each boiler to be supplied with pop safety-valve, steam-gauge, water-column, gaugecocks and standpipe, asbestos blow-off cock, stop and swinging check-valves, and necessary flanges for steam-pipe connections riveted to boilers.

General Conditions.—Boiler to be set to return the gases to the front underneath the bottom of the boiler. All material and workmanship to be first-class in every respect, and certificate of test and inspection furnished.

Remarks.—That the type of boiler here specified has demonstrated its ability to perform its work is unquestioned; not only under the pressure specified and called for in electric service, but even the higher pressures used in the merchant marine to-day; taken in connection with its ability to work under high pressures successfully, it has good average economy. The other point that makes it most fitted for the service mentioned is the small space occupied, together with its enormous capacity or ability to furnish almost any amount of steam when forced, and this, too, of good quality as regards percentage of moisture. This, however, is easily accounted for by the large liberating surface at the water-line. The firing of the boiler internally is another advantage offered by this type of boiler, when contrasted with the repairs necessary to furnaces, boiler settings, etc.

PIPING.

Piping is a part of the power station which, in the minds of many people, does not require much attention. We believe, however, that it is one which should receive the most careful and earnest attention of the constructing engineer. The safety, good working, and reliability of a power station is dependent on the piping as much as any other factor in its outlay. We have tried to generally outline here, under the head of "piping," a few thoughts and suggestions which are supplemented by some sketches of what has been our practical experience of the requirements in this line.

PIPING SPECIFICATION.

The flanges should be recessed, male and female, for gasket, to prevent the "blowing out" of the same. This effect is considerable if the gasket is thick. The flange is screwed on the pipe and then caulked in on the inside. The small recess in the back of the flange around the body of the pipe is to be filled and caulked with babbitt or steam metal, in case of leakage of screw joint when circumstances will not permit, for the time being, to break the joint and recaulk the pipe itself. The threads on the pipe should be cut by the same person, chasing the threads on flanges so as to secure the same taper on both—a very essential condition to a tight job. The screw joint should be made up in plumbago, to be removed, if necessary, at a future time without breaking. The flange should be designed to be equally strong through bolt-holes as any other part of the flange. This is easily done by means of bosses about bolts.

There is one thing that should be remembered in the design of cast-iron flanges, and that is that it is hardly possible to get them too heavy for the work. The initial strain due to screwing them on the pipe is so large that the factor of safety that remains is not usually sufficient to withstand the higher steam pressure, together with the increased expansive strains due to the increased temperature at the higher pressure. The weak point in the theory of cast-iron flanges is as follows:

Conceive the flange to be made up of laminæ in the form of concentric circles. In case the first lamina is strained beyond its ultimate strength by screwing up, then although no disastrous results will be detected immediately, the life of the flange will be very short, and it will fail by cracking, commencing nearest the threads—*i.e.*, at its smallest diameter, and gradually radiating outward. This theory is similar to the one used in the design of hydraulic cylinders, and is equally applicable so far as screwing up the flanges is concerned. From this, one can see that it is possible to screw up a flange too tight; a fact too often overlooked in the anxiety to get a tight job, and usually done when the threaded work is poor.

Gaskets.—Copper corrugated gaskets are all right in the case of mains where the joints are made up with the ends of the pipe free to move; in fact, they could be omitted altogether in such a case, and the joint made iron to iron; but there is the practical consideration that in case of repairs (and that time is sure to come) the line will be always distorted from its original position—*i.e.*, it will have initial strains, due to some part of it having steam on to run a portion of plant; and when the joint is broken for repairs, it is possible to bring the flanges back in the same relative position they previously occupied, and for this reason alone I prefer the use of a wire-insertion rubber gasket of very thin material, say not over 1/16in. thick. This will make up, or rather allow, for this slight inequality of the flange facings, and permit a tight job to be made where a copper gasket or iron to iron would leak.

The weak point in these designs is the fact that all caulking is done from the outside at the joint, and that it makes a series of small traps for water of condensation. The system would give more trouble after it once commenced to leak than the one mentioned. The use of steel is good practice, and by making such a system with long radius bends of the pipe itself, would give good satisfaction.

Expansion Joints.—The average slip joint will not answer at all for high pressure, for when the packing is adjusted sufficiently tight to prevent leaking, it will also be sufficiently tight to keep the joint from moving to take up the expansion, and if loose enough for this, it will be found to leak.

The corrugated copper expansion joint offers a solution to the difficulty of expansion joints, but when made as most of them are to-day in this country, they almost defeat the object they seek to attain. The corrugations in these joints are made literally like the threads of a screw, whereas they should be made without longitudinal pitch, so as to prevent any torsional action tending to make them rigid. Probably the best way to take up the expansion in a high-pressure system is by means of long pipe bends of easy radius, and with all branches so located, and of sufficient length to take any expansion of the mains by means of their flexibility on account of their small size. Judicious arrangement of this sort can be made without the use of any expansion joints whatever. Under restricted and peculiar conditions copper bends with iron band can be used with good effect, if commercial considerations are not prohibitive.

Pipe.—Wrought iron or steel lap-welded pipe will answer most conditions successfully, even in case of long bends or elbows made from this material. The tests should be rigid to avoid defective seams caused by bending. Extra heavy pipe will not be found necessary.

Fittings.—These should be of the best charcoal iron, true to pattern, and of workmanlike finish. The flanges should be ribbed in preference to being thickened up, on account of shrinkage strains in metal.

Valves.—There should be gate valves, operated by an outside screw. The spindle should be of steel, and tinned. The body should be extra heavy, and ribbed, to prevent any springing, which would cause the valve to leak around the seats when closed. The valve body should be stiffer than any other part of the system in order to have all the valves tight. The seats of valves should be bronze or brass, and able to withstand the high temperatures of the high steam pressures, as well as very non-corrodible.

All valves over 7in. diameter of port should have a by-pass valve (a smaller valve about 1¼in. to 2½in. in diameter) of exactly similar type, so that the pressures can be equalised on both sides of the large valve before it is opened by means of the smaller one. This relieves the excessive strain on the spindles and seats, and should always be used on high-pressure work.

Support.—A high-pressure steam-pipe should always be supported, when possible, from underneath, by means of some solid mass, so that its weight would rest directly upon this support. This method, when it is possible to follow it, will be found to eliminate that vibration so often noticed, and the result of which is leaky joints caused by the racking and straining of the whole piping system. When the suspension method is used there is always one or two points which, if held firmly, will stop the vibration of the whole system. Other positions will cause a general leakage. Experiment will determine these points. Piping should be rigidly secured by proper means.

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* Paper read before the Chicago Electric Club, Dec. 19, 1892.

Bolts.—All bolts should be of double-refined iron or low grade steel. Their weakest point is directly under the head, and a good test is to place one in a vice, holding it by the head and bending the shank over by means of blows from a hammer. A good bolt should stand this without showing any cracks whatever at the head. Both head and nut should be hexagonal on account of the limited space in which it is often necessary to use a wrench. The whole system of piping should be blown out thoroughly with steam before the engine connections are made, to prevent any chips or dirt from being carried through to the cylinders.

GENERATORS.

In describing the type of generator required, it is necessary to be more specific as to the class of work it is required to perform, and particularly as regards the voltage, etc., than in our other departments. We will therefore in the main describe, as far as concerns the generator and switchboard, apparatus especially adapted for railway power service.

Generators for electric railway service should be constructed with a view to efficient handling of variable loads and excessive overloads for short periods. They should be mounted on a brick foundation set on a bed of concrete. The top of masonry should be provided with a wooden foundation base; this wooden base to be built up of two layers of timber, with tar paper or some good insulating material between the layers, the first layer bolted by means of foundation bolts direct to masonry, the upper layer being bolted to the lower layer, thus ensuring good insulation between the iron foundation frame of generator and the ground. This precaution is taken with a view of protecting the generator from lightning coming in over the line.

Generator Frame in Belted Type.—The foundation frame of the generator should be bolted directly to the wooden cap of the foundation, and provided with grooves and sliding arrangement for tightening the belt. The general design of frame and magnets in the latest type of generators of large capacity is a circular casting built up of two or more parts and concentric with the shaft of the machine. The pole-pieces are in many cases made of laminated iron cast direct into this frame; the field wire, both shunt and series, being wound on adjustable spools, which, by suitable flanges and clamps, are bolted direct to the frame when slipped over pole-pieces. The compound field of the machine should provide for sufficient fall in potential due to loss in armature at variable loads, and to maintain a constant E.M.F. at the switchboard. The practice of over-compounding a machine so as to obtain an increased E.M.F. with increased load—in some cases 10 per cent.—is not a good method where a number of generators are in operation, for the following reason:

The machines over-compound in proportion to the load on themselves, and not in proportion to the load on any individual feeder, the result being that if, for instance, two machines are running under condition of full load and have increased E.M.F. 10 per cent. at the switchboard, they may be feeding into two feeders: one feeder which is considerably overloaded, and the other which is very lightly loaded. The result is that the lightly-loaded feeder is supplied with a high E.M.F., higher than necessary, and the overloaded feeder is the only one benefited. When a third machine is thrown into this combination the E.M.F. is reduced, as the load is divided then between three machines instead of one, and consequently the overloaded feeder is not assisted to the extent which it was before.

A better method in large installations is to provide an auxiliary bus which can be connected at any time with any one or more generators, this auxiliary bus to be run at a higher E.M.F.—say, at 575 volts to 600—and run in connection with it the heavily-loaded feeders, or those feeders which are of much greater length than the average of the system. This method reduces the quantity of wire required to run a system and maintain a fairly uniform pressure over the different lines. Arrangements should be made on the switchboard so that any feeder or any generator may be connected to or disconnected from this auxiliary bus, or to or from the main bus, the main bus to be run with an E.M.F. of 500 volts, the same as in ordinary practice. In other words, this divides the switchboard up into two distinct arrangements, electrically separated from each other. This has been tried in practice and has proved very satisfactory.

To return to the construction of the generator, the armature of the machine should be run in self-oiling bearings, made with adjustable globe seats, so as to ensure perfect alignment, and provided in the larger-sized machine with outboard bearing at the pulley end of the shaft.

The commutator should be of ample width to ensure good contact service between commutator and brushes for a 500-volt machine. Carbon brushes have proved very satisfactory, and are almost universally used at the present time. The machine should be so constructed that the brushes should not need readjustment for any change of load from zero to 25 per cent. overload. There should be practically no sparking at the points of contact. The generator should be provided with a double-pole switch, so as to enable the operator to disconnect the generator entirely from the system when it is required to do repairs, overhaul the machine, or shut it down.

The generators should be capable of developing their normal output for a continuous run, and also capable of developing at least 25 per cent. above their normal capacity for short periods without undue heating of any part of the armature, bearings or fields.

There are several methods of connecting the generators with the switchboard, and the two following are given:

The three wires from the machine—namely, the positive, negative, and equalising wires—are all carried direct to a three-pole switch; the equalising wire is connected to an equalising bus, and the ground wire to ground bus. The line wire of the machine from the switch is connected to an ampere-meter and also to an automatic cut-out, and from there to the main bus. If an auxiliary bus is used the wire, instead of being connected directly to bus, is connected from the automatic cut-out to a transfer switch, which enables the wire to be connected through to auxiliary or the main bus. The main bus is in connection with a main ampere-meter, the other terminal of the ampere-meter being connected directly to the feeder bus. The feed wires are brought in the station to the switchboard and attached to a single-pole switch; from this to an ampere-meter, then through an automatic cut-out, then to the feeder bus, each feeder being provided with a lightning arrester. The line wire from the machine above described should be taken from the series field side of the machine, as this series winding affords a very good protection from lightning coming in over the line, acting as a very efficient "kicker coil." The ground bus should be connected direct to the rails near the station and also to a suitable ground bus within the station.

To ensure an equalisation of load between the various generators all the dynamo mains of the same potential should be of equal resistance, provided the machines are of equal capacity, and have a resistance inversely proportionate to their capacity, if of unequal capacity. The usual method followed is to calculate the size of the mains required for the generator farthest from the switchboard; then make the generator mains of the other machines of the same length as this, using the same size wire. In other words, all the positive mains will be of equal resistance, all the negative mains will be of equal resistance, and all the equalising mains will be equal. It is not necessary to make the equalising mains of any larger carrying capacity than the others.

Great care should be exercised in making joints between the different instruments and mains to ensure good conductivity, as a poor joint will throw the most careful calculations out. The usual method adopted now for making joints is to use a mechanical clamp having the contact surfaces perfectly clean and of ample surface contact. In operating the switchboard, care should be taken that all instruments required to be used to throw a generator in or out of line should be so arranged that the operator is not required to leave his position at the switch controlling the generator at the board. To obtain this result the voltmeter may be arranged on a carriage which can travel along the length of the board and make automatic connection to any generator as it reaches a position exactly opposite the instruments connected with that generator. By suitable arrangements the voltmeter can be switched, when in position, with the feeder bus, and also with the generator which it is to test, so that without moving the instruments the pressure of the line or pressure of the machine may be taken, and the machine brought up to the same E.M.F. of that of the line before being connected into service. The automatic regulators on the generator should be adjusted to cut out the generator when the overload of the machine is more than it will safely carry even for short periods. The automatic regulators on the feeders should be adjusted for an excessive overload on that feeder, as in many cases of railway service the feeder is subjected to excessive overloads for very short periods, and it is a source of great inconvenience to have an automatic regulator continually cutting out the line on overloads of very short duration.

The latest types of switchboards are built up of fireproof material perfectly incombustible. The framework may be built up of iron pipe or of angle iron, and if located near the wall it should be set up at least 20in. to 24in. from the wall, and iron braces from top of frame anchoring into the wall. The general design of this frame is dependent entirely upon the number of instruments and their location on the board, as care must be taken that, with the present method of back connections on the instruments, the cross-bars of the frame do not interfere in any way with the bare wire coming through back connections, and should be a safe distance to prevent any danger from grounds. To this iron frame should be securely bolted large slabs of marbleised slate or white marble. Asbestos cloth or other cushioning device should be interposed between the slate and the contact points of the iron frame, so that the slate slabs may be securely fastened without risk of breakage. If slate is used, it should be carefully tested after all holes are drilled, to ensure perfect insulation. All instru ments to be used on board should then be connected directly to the slate slabs and not set on independent sub-bases unless absolutely necessary. As before mentioned, all connections on instruments should be made from the back of the board and no wiring exposed from the front. At the same time, all connections and wire should be so located as to be easily accessible for repairs or inspection. Where wires are passed through the floor below the switchboard, the holes should be fitted with a floor insulator of hard rubber made watertight, so that the floor beneath the switchboard may be kept perfectly clean, and if any water accumulates, it shall not be able to follow the wire down through the floor.

In addition to the foregoing arrangement of the switchboard, the following plan may be used. Instead of running three wires directly from each generator to a three-pole switch on the switchboard, take the equalising wire from each machine and run to a common point, using a short bus, or any method of connecting which may be deemed most practical; so that all equalising wires shall be of equal resistance to this point. Then take the ground main from the generator and run directly to the ground bus. The line main from the generator is then taken directly to the switchboard and connected to a single-pole switch. From this switch connections will be made similar to the board already described. This arrangement provides a switchboard in which all wires are of the same polarity, and it ensures a very safe method of operating. The only objection to this is that it is impossible to cut out the machine entirely from the switchboard, and it is therefore advisable in using this method to have each generator equipped with a double-pole switch attached directly to the generator controlling both lines.

Regarding the grounding of positive or negative wire, a great variety of opinion is expressed by engineers as to the better method; some advising the grounding of positive, and others the neutral wire, the result which it is desired to obtain being a condition which will produce the least electrolytic action at contact points in the ground return, such as bond wires, supplementary, etc.

We have tried to outline in general here the important factors for consideration in an ideal central power station, our desire being more to lead up to general line of thought or discussion on the matter, and point out some of the most desirable features in relation thereto. If we bave accomplished this, our purpose has been fulfilled.

Trusting the matter will meet with your earnest and careful consideration and free discussion, it is very respectfully submitted.

LEGAL INTELLIGENCE.

THE NATIONAL TELEPHONE COMPANY, LIMITED, v. BAKER.

Mr. Justice Kekewich on Saturday morning delivered judgment in this case, which is one of momentous importance to telephone companies who have adopted in large towns the system known as the "telephone exchange," and also to tramway companies using electricity as the motive power for their tramcars. The action was brought by the plaintiff company, who are using their "exchange" system at Leeds, to restrain the nominal defendant, who represented the Thomson-Houston International Electric Company, and has recently constructed an electric tramway in Leeds, which is under the control of the Corporation, from committing an alleged nuisance in the working of the tramway. The nuisance complained of was caused by electrical disturbance, the electric tramcars affecting, it was said, the telephone wires to such an extent as to prevent the plaintiffs' subscribers from communicating with one another, and the question was whether the plaintiffs could prevent the defendant from causing this natural electrical disturbance to the prejudice of their telephonic system. The point raised by the action appears to be an entirely novel one in this country, though it has been much discussed in the United States. During the progress of the action his Lordship directed certain experiments to be conducted at Leeds by Mr. Macrory, the well-known counsel usually engaged in patent cases, with a view to ascertaining the nature and extent of the alleged disturbance, and this report was duly made to his Lordship. The trial of the action occupied several days, and at the conclusion of the arguments, on January 17th, his Lordship reserved judgment.

Sir R. Webster, Q.C., Mr. Warmington, Q C., Mr. Fletcher Moulton, Q.C., Mr. Micklem, and Mr. R. W. Wallace appeared for the plaintiffs; and the Solicitor-General (Sir John Rigby, Q.C.), Mr. Bousfield, Q.C., and Mr. Dunham for the defendant Mr. Morton Daniel held a watching brief for the Thomson-Houston International Electric Company.

Mr. Justice Kekewich said: As between the National Telephone Company, whom I shall treat as the sole plaintiffs, although another is associated with them, and the Leeds Corporation, whom I shall treat as the real defendants, although not appearing on the record, there is no question of title and no question but that each is lawfully exercising undoubted rights. Nor is there any question but that the acts of the defendants interfere with the exercise by the plaintiffs of their lawful rights. This would, I believe, have been undoubtedly true if the case had been thrashed out on evidence without the advantage of Mr. Macrory's report; but that report renders it unnecessary to deal with the evidence on this point. And the interference is of a serious character, so that, if actionable, the remedy would properly be by injunction rather than by damages. The real and only question in the case is whether the interference is actionable. It was practically admitted by the plaintiffs, and my own view certainly is, that, if they can maintain the action against the defendants at all, it must be on the application of the principle now well known as that of Fletcher *v.* Rylands (L.R., 3, H.L., 330). That principle, for the purposes of application to the case in hand, may conveniently be stated by reference to the second of four propositions set out in the fifth chapter of Mr. Garrett's book on the "Law of Nuisance," which I have consulted in connection with more than one point in this case, and gladly take this opportunity of mentioning as a work of uncommon merit. The proposition is I think, capable of improvement by the substitution for "non-natural" of "extraordinary," which is the term employed by Lord Kingsdown in defining somewhat analogous water rights in his well-known judgment in Miner *v.* Gilmour (12 Moore's P. C. Cases, 131). The land into which the plaintiffs and defendants alike discharge their electric current does not belong to either of them; but, for the reasons above indicated, there cannot, as between them, be any question that the principle ought to be applied (if it be applicable at all) on the basis of their being absolute owners. That principle has never yet been applied in English law to such a matter as is now under consideration, and perhaps it would not be too much to say that those who enunciated the law in Fletcher *v.* Rylands, and have commented on and followed it in other cases, never had present to their minds the application of the doctrine to an electric current, and the possible consequences of its discharge into the earth. The question has been carefully considered in America, and I have studied with deep interest the case of Cumberland Telephone and Telegraph Company *v.* United Electric Railway (42, Federal Reporter, 273). The judgment of the Court in that case, though in nowise binding on me, has commanded my earnest attention and respect, and but for one circumstance I should not hesitate to allow my own conclusion to be guided by the powerful arguments there set forth. That one circumstance is the want of full adoption of the principle of Fletcher *v.* Rylands. American law apparently holds the owner of land used for a non-natural or extraordinary purpose responsible for the consequences of such user to his neighbour only when they result from that owner's negligence, and if he can satisfy the Court that he has not been guilty of negligence, the resulting damage to his neighbour is not actionable. It seems to me that if the principle of Fletcher *v.* Rylands had been fully adopted in America, the conclusion of the Court in the case just cited must have been different. I believe that in Scotland, too, the principle of Fletcher *v.* Rylands has not been accepted and is not regarded as consistent with justice between man and man. It does not fall to me to consider so large a proposition. The principle is thoroughly well settled here, and my duty is merely to consider whether it is applicable. It would be easy, of course, to point out differences between all the cases to which it has hitherto been applied and the present; and I have already said that injury arising from such a case as the discharge of electric current can scarcely have been contemplated by any judge in previous cases. But after reflecting much on the novelty of the case, on the arguments addressed to me, and on the peculiarity of an electric current as distinguished from every other power, I fail to see any reason why the principle should not be applied to it. I cannot see my way to holding that a man who has created, or, if that be inaccurate, called into special existence, an electric current for his own purposes and who discharges it into the earth beyond his control, is not as responsible for damage which that current does to his neighbour as he would have been if, instead, he had discharged a stream of water. The electric current may be more erratic than water, and it may be more difficult to calculate or to control its direction or force, but when once it is established that the particular current is the creation of, or owes its special existence to, the defendant and is discharged by him, I hold that, if it finds its way on to a neighbour's land and there damages the neighbour, the latter has a cause of action. At any rate, I think that if a distinction is to be taken between this and other forces for this purpose, that distinction must be made by a higher tribunal and not by a judge of first instance. It was endeavoured to be argued on behalf of the defendants that the current injuring the plaintiffs was only part of the general body of electricity which may be now said to exist everywhere and to be proceeding in every direction; but the effect of the defendants' operations is to collect a particular portion of this body and to discharge it into the earth at a particular spot; and there can be no doubt but that the disturbance of the plaintiffs' telephonic system is caused by the particular quantity thus discharged. Assuming the action to be maintainable on the principle of Fletcher *v.* Rylands, the defendants rely on two answers to the plaintiffs' claim. First, they say that the plaintiffs might, by an alteration of their system—that is, by the adoption of what is known as the "metallic return"—prevent the disturbance complained of; and, secondly, they say that they, the defendants, are acting under statutory powers, and that if, in the proper exercise of those powers they injure the plaintiffs, they are free from blame. The first answer is, to my mind, without foundation. The man who complains of his land being thrown out of cultivation by the incursion of water escaping from his neighbour's reservoir must not be told that he has no right of action because, if he had interposed a wall, or otherwise taken care to protect himself, the water would not have reached his land. He is using his land in a natural way, is not bound to take extraordinary precautions, and is entitled to rely on his neighbour also using his land in a natural way, or, if he uses it otherwise, taking extraordinary precautions to prevent damage to others therefrom. There is, no doubt, a body of evidence to show that a system different from that adopted by the plaintiffs has been adopted elsewhere with advantage and may possibly prove to be the most convenient though more expensive for them; but the evidence also proves that their present system has been largely adopted and is received with favour by many competent to form an opinion. It also has the merits of economy. They are carrying on their own business lawfully and in the mode which they deem best, and I cannot oblige them to change their system, because they might thereby possibly enable the defendants to conduct their business without the mischievous consequences now ensuing. True it is that the analogy introduced above fails to this extent, that the plaintiffs are using the law for an extraordinary purpose, but admittedly it is a lawful purpose; and though under an obligation to obviate mischief from their own operations to their neighbours, they are under none, in my judgment, to protect themselves from the defendants or others. The outflow from one reservoir might easily destroy another; but, so far as I am aware, there is no principle or authority in English law for rejecting a claim for damage by the owner of the latter on the ground that his user, as well as that of his neighbour, is extraordinary. The second answer of the defendants to the plaintiffs' claim has required more examination. Having recently had occasion, in Allison *v.* City and South London Railway Company, and again in Rapier *v.* London Tramways Company, to consider such a plea as is here put forward, and to consider many authorities, and, in particular, the cases of Metropolitan Asylum District *v.* Hill (6 App. Ca., 193), and London, Brighton, and South Coast Railway Company *v.* Truman (11 App. Ca., 45), and their application to different provisions and circumstances, I do not find it necessary again to state my view of the law or of the lines by which I ought to be guided in applying it to a particular case. Therefore I shall but briefly explain the reasons for my conclusion that the defendants' plea is good in law, and that they are not responsible to the plaintiffs for the mischief caused by their works. The defendants' authority is derived under a provisional order confirmed by Act of Parliament. Such provisional orders in connection with tramways and many other undertakings of a public character are now common, and, I think, must be treated as "a well-known and recognised class of legislation" equally as much as Railway Acts, which were referred to in those terms by the Lord Chancellor in London, Brighton, and South Coast Railway Company *v.* Truman (11 App. Ca., 53). The Railway Acts (again using the language of the Lord Chancellor in the same case) were assumed to establish the proposition that the railway might be made and used, whether a nuisance were created or not, and in my judgment a like proposition must be assumed to be established by the provisional orders, one of which is here under consideration. The defendants are expressly authorised to use electrical power, and the Legislature must be taken to have contemplated it and to have condoned by anticipation any mischief arising from the reasonable use of such power. A distinction was endeavoured to be made between cases where extraordinary powers are directly sanctioned by the Legislature, and those where it is left to some other authority (in this instance the Board of Trade) to determine whether, if at all, they may be brought into operation. It is within the competence of the Legislature to delegate its authority, and when once that delegated authority has been properly exercised by the agent to whom it is entrusted, the sanction is that of the Legislature itself, just as much as if had been expressed in the first instance in an Act of Parliament. The defendants relied on the 51st section of the provisional order. They argue that the exception there made in favour of the telegraphic, which would include telephonic, lines of the Postmaster-General indicates that interference with any other like lines was intended to be permitted. The reference supports the more general argument, and I have therefore mentioned it; but I rest my decision more on the established principle laid down in many cases, and ultimately ratified by the House of Lords in London, Brighton, and South Coast Railway Company *v.* Truman. To this plea of statutory power the plaintiffs have a rejoinder. They say that such power cannot avail the defendants, unless they have acted reasonably in the exercise thereof and have done their best to avoid injury to their neighbours. The argument being sound in law, one is compelled to examine the facts. The defendants work their tramways on what is called the "single-trolley system." There are other systems which have from time to time been used, and, it seems, are still in use elsewhere, and there are at least some good reasons for the conclusion that, by the adoption of one or other of these systems, the defendants might wholly or partially avoid the mischief which they now occasion. There is a contest on the evidence whether any of these other systems can be regarded as good apart from comparison with that of the defendants; and there is a further conflict of evidence whether, if good, they are comparable in merit with that of the defendants. My conclusion from the evidence is that the defendants' system is, on the whole, the best which practical science has yet discovered, but there is no occasion really to go as far as this It is enough to say—and about this I entertain no doubt—that it is at least as good as any other, and has been proved by experience, especially in the United States, where there have been larger opportunities for experiment and consideration, to be as likely as any other to meet the requirements of traffic, and the convenience of all concerned in the protection of the site of tramways for the use of legitimate purposes other than those of the tramway undertaking. It cannot be that in the application of the law which I am now considering, the Court is bound to hold a railway or other company liable for the consequences of acts done under statutory powers because it has not adopted the last inventions of ever-changing, ever-advancing scientific discovery. It is surely impossible, with any regard to that common sense which after all is the foundation of this and many other branches of law, to say that a railway company which was not liable last year, last month, or even yesterday, because, until then, its undertaking was carried on according to rules acknowledged to be the best, it is liable now, not because those rules have been proved to be altogether wrong in practice or unscientific in principle, but because some diligent worker in this department has discovered what is held for the moment to be a large improvement, but may to-morrow turn out to be only a step in the progress of further advance; and yet this might be the necessary conclusion in many cases, and, indeed, might be the necessary conclusion here, if I were driven to support the plaintiffs' claim on the ground that the single trolley system, so largely approved where it has been largely tried, does not avail the defendants as a proper exercise of their statutory powers because another system is in use, and apparently successful use, at Budapest or elsewhere. I do not wish to prejudice the question whether a charge of negligence in the exercise of statutory powers can be supported by cogent evidence that the company exercising those powers has failed to adopt alterations or precautions, which sufficient experience has shown to be of large, indisputable, and permanent value. That question may easily arise in many of the disputes which are likely enough from time to time to occur between public companies and those whom the operations injuriously affect; and it may even arise between the parties to this litigation. Suffice it to say that it does not arise now. Holding on the above grounds that the plaintiffs cannot maintain an action, either for an injunction or for damages, against the defendants, I must order them to pay the general costs. If ever there has been or can be a case to which the distinction between the two scales of cost is properly applicable, this is the one; and the costs must be taxed on the higher scale. But it remains to make an exception, and that of some extent. I have already stated that the interference with the plaintiffs by the defendants is beyond doubt. I do not think that this ought to have been litigated. Mr. Macrory's report shows that one fair experiment would have proved the facts about which there really was very little doubt, independent of his report, and that much time was uselessly spent on evidence. Not only must the plaintiffs be excused payment of the defendants' costs of this issue, which must be defined to be the issue whether the plaintiffs' telephonic system was in fact interfered with by the defendants' operations, but the costs thus excepted from the general costs of the action must be borne by the defendants, and set off. Those costs will, of course, include those incurred in the experiments conducted at Leeds under Mr. Macrory's superintendence. They must also include the fee payable to Mr Macrory which it was agreed I should settle. I have communicated with him, and ascertained the time occupied, and also the expenses incurred by him in railway journeys and the like, including the expenses of the gentleman (Mr. Cuninghame) whom he asked to assist him, and taking into consideration these items, I have fixed the fee at 50 guineas to cover all expenses, and also such fee as he thinks fit to pay Mr. Cuninghame. I am glad to think that the course pursued with the concurrence of both parties of sending him down to make experiments and report, was not only successful in finally settling an issue of fact, but also shortened the trial and saved the further costs, which further dispute on this point would necessarily have involved. There will be judgment for the defendants with costs, modified in the manner above expressed.—*Times.*

COMPANIES' REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors: S. William Silver, Esq. (chairman), Abraham Scott, Esq., Matthew Gray, Esq. (managing director), Robert Henderson, Esq., the Hon. Henry Marsham, A. Weston Jarvis, Esq.

Report of the Directors for the year ending December 31, 1892, to be presented at the twenty-ninth ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, London, E.C., on Tuesday, February 14, 1893, at 12 o'clock.

The annexed accounts show the net profit for the past year to be £99,161. 11s. 7d. Adding £42,073. 5s. 10d. brought forward, and £43,110 premium on 8,400 new shares issued in March, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £159,344. 17s. 5d. Of this balance the Directors have added to the reserve fund £75,000 (including the premium on new shares), and recommend the distribution of a dividend of 10s. and a bonus of 5s. a share, free of income tax, amounting to £37,500, making, with the interim dividend, a total payment for the year of 12½ per cent, and leaving £46,844. 17s. 5d. to be carried forward. The Company's ordinary business continues satisfactory. The principal cable work of the year has been the completion of the manufacture and the laying of about 2,000 miles for the South American Cable Company, and the manufacture of about 2,600 miles for the Central and South American Telegraph Company. The ss. "Silvertown" sailed on the 22nd of last month to lay the latter cable between Peru and Mexico. The works and machinery at Silvertown and at Persan-Beaumont are in the usual state of efficiency. Mr. S. Wm. Silver and the Hon. Henry Marsham, the directors retiring by rotation, offer themselves for re-election. Mr. J. Weise, of Messrs. Turquand, Youngs, Weise, Bishop, and Clarke, retires frem the auditorship; but Mr. J. F. Clarke, of the same firm, offers himself for election in his place.

BALANCE-SHEET, DEC. 31, 1892.

Dr. *Capital and Liabilities.*	£	s.	d.
Amount of authorised share capital	812,000	0	0
Share capital—Amount subscribed and paid on authorised issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	200,000	0	0
Reserve fund	400,000	0	0
Steamers' maintenance fund	10,000	0	0
Debts owing by the Company and suspense account	77,438	16	9
Unclaimed dividends	294	0	0
Proposed dividend of 5 per cent. and bonus of 2½ per cent.	37,500	0	0
Amount carried forward to 1893, as below	46,844	17	5
	£1,272,077	14	2
Cr. *Assets and Expenditure.*	£	s.	d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery and steamships	489,745	1	2
Debts owing to the Company	105,489	7	1
Cash with bankers, on deposit, and in hand	63,327	3	10
Bills receivable	9,176	3	1
Stock-in-trade, including cable and expenditure on account of contracts	221,121	16	8
Debentures and shares in other companies	227,865	15	0
Cash, stock, etc., at Persan and other agencies	155,352	7	4
	£1,272,077	14	2

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING DEC. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Salaries, interest, rent, rates and taxes, repairs, and general expenses				67,853	7	4
Bad debts				1,250	10	3
Income tax				1,800	14	0
Depreciation written off buildings and machinery				15,700	7	6
Directors' remuneration (minimum)				2,000	0	0
Balance, profit for the year, carried down				102,161	11	7
				190,766	10	8
Addition to reserve fund				75,000	0	0
Interim dividend of 5 per cent. paid in July	£25,000	0	0			
Proposed dividend of 5 per cent.	25,000	0	0			
,, bonus of 2½ per cent.	12,500	0	0			
				62,500	0	0
Balance to be carried forward to 1893				46,844	17	5
				£184,344	17	5
Cr.				£	s.	d.
Gross profit, including interest on securities, and after charging commission				190,766	10	8
				£190,766	10	8
Balance brought down	£102,161	11	7			
Less additional remuneration due to Directors after payment of 10 per cent. to shareholders	3,000	0	0			
				99,161	11	7
Premium on 8,400 new shares issued				43,110	0	0
Amount brought forward from 1891				42,073	5	10
				£184,344	17	5

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

Directors: The Right Hon. the Earl of Albemarle, K.C.M.G., A.D.C. (chairman), the Right Hon. Lord Egerton of Tatton, Sir Henry C. Mance, C.I.E., James Pender, Esq., Thomas Parker, Esq., M.I.C.E, Moritz Immisch, Esq.

Report of the Directors to be submitted to the shareholders at the second ordinary general meeting to be held at Winchester House, Old Broad-street, E.C, on Tuesday, February 14, 1893, at 3 o'clock p.m.

The Directors beg to submit the accounts of the Company up to the 30th September, 1892. Some delay has necessarily occurred in the preparation of the balance-sheet and report in consequence of several changes in the executive, and the illness of the Chairman and certain members of the staff. The Directors have also awaited the preparation of an exhaustive report by the auditors, which accompanies the balance-sheet and gives the fullest information regarding the various itews. The anticipations of the Directors as expressed in the last report have not been fulfilled, especially with regard to electric traction; the boat season has proved disappointing, owing to the unfavourable state of the weather, but the fleet of launches has been maintained in a high state of efficiency and the service has given general satisfaction. A steady development of this branch of the business is hoped for. Four launches were engaged on the Manchester Ship Canal throughout the summer, but unless advantageous offers are received for their future employment, the whole of the fleet will be brought to the Thames. With regard to electric traction, the Directors regret to report that in consequence of a misunderstanding with the North Metropolitan Tramways Company on account of the unsatisfactory condition of the roads, the service at Barking has been discontinued. Much valuable experience has, however, been gained during the work, and the Directors feel confident that under ordinary favourable circumstances, this form of traction will finally become a commercial success. Arrangements are now being made for the transfer of the Kentish Town Works to Millwall, where water-side premises have been secured and the works necessary for the working of Parker's copper deposition process are nearly completed. The Directors anticipate a very profitable business in connection with this work and the manufacture of copper wire. As explained in the auditor's report, nearly the whole of the amount carried to the debit of profit and loss is made up by amounts written off on account of depreciation of stock, plant, machinery, patent rights and goodwill. The volume of business might have been larger, but the Directors have steadily declined all business of a speculative character. The vacancy on the staff caused by the retirement of Mr. Robert Macpherson, our late manager, has not yet been filled up. The head office expenses have been much reduced during the latter portion of the year, and every effort of the Board is being made to carry on the business with the greatest possible economy. The Directors are hopeful that by careful attention to all branches of the business they will be able to present a much more satisfactory report at the end of the current year. Since the last general meeting two of our directors, Mr. Thomas Fuller and Mr. James Paxman, have retired. The Board has been strengthened by the addition of Thomas Parker, Esq., M.I.C.E. In accordance with the articles of association, two of the directors, the Right Honourable the Earl of Albemarle and Lord Egerton of Tatton, retire, both of whom are eligible and offer themselves for re-election. Messrs. Ward and Wilding, the auditors of the Company, retire, and offer themselves for re-election.

TRADING ACCOUNT FROM OCT. 1, 1891, TO SEPT. 30, 1892.

Dr.	£	s.	d.
Sundry purchases, expenses, and cost of production during the 12 months at Kentish Town Works, Barking, and the several river stations, including amount of stock on hand at Sept. 30, 1891, as reduced	36,704	7	8
	£36,704	7	8
Cr.	£	s.	d.
Sundry sales and work executed during the 12 months, including hire and charging of launches, and amount of stock in hand, as at Sept. 30, 1892	32,695	3	9
Balance carried to profit and loss account	4,009	3	11
	£36,704	7	8

PROFIT AND LOSS ACCOUNT, FROM OCT. 1, 1891, TO SEPT. 30, 1892.

Dr.	£	s.	d.
Balance from trading account	4,009	3	11
Head offices expenses	5,549	17	5
Sundry amounts written off during the 12 months for estimated depreciation on plant, machinery, etc., maintenance and depreciation of Barking plant and installation, and generally	39,871	12	10
Amounts written off patents and patent rights, goodwill, etc.	20,000	0	0
	£69,430	14	2
Cr.	£	s.	d.
Transfer fees, discount and premiums from apprentices, compensation, etc.	148	17	10
Amount carried to balance-sheet	69,281	16	4
	£69,430	14	2

BALANCE-SHEET, SEPT. 30, 1892.

Dr.	£	s	d.	£	s.	d.
Capital—Authorised issue of 35,000 shares of £10 each, as follows:						
10,000 preference shares of £10 each	100,000	0	0			
25,000 ordinary shares of £10 each	250,000	0	0			
	350,000	0	0			
Less 1,408 ordinary shares not yet issued, £14,080; £2 per share on 9,844 preference shares not yet called up, £19,688; calls unpaid, £6,544. 18s. 5d.	40,312	18	5			
				309,687	1	
Sundry creditors—Open accounts	5,044	16	1			
Bills payable	2,445	12	6			
Directors' fees	862	10	0			
Suspense account	895	15	11			
				9,248	14	6
Contingent liabilities on disputed accounts, *re* Barking, maintenance, etc., about	850	0	0			
				£318,935	16	1

Cr.	£	s.	d.	£	s.	d.
Capital expenditure—For purchases of the businesses of the Electric Traction Company, Limited, and Messrs. Immisch and Co. (including all plant, machinery, trade and other fixtures and fittings, launches, boats, charging stations, and all patents and patent rights, etc.), as per last balance-sheet	246,660	18	0			
Add additional expenditure during the year as follows—On account of purchase of patent for depositing copper (being part of £20,000 agreed price)...........................	10,000	0	0			
On account of building of works at Millwall for same (under contract for £4,200)	1,500	0	0			
	258,160	18	0			
Less amount written off during the year for estimated depreciation, after providing for sundry additions, etc., during the same period (including the amount written off book value of patents, patent rights, goodwill, etc.) ...	38,896	5	8			
				219,264	12	4
Sundry debtors..................... ...	8,425	1	2			
Less reserve to cover bad and doubtful debts	2,766	11	0			
				5,658	10	2
Stock on hand, as per inventories...........				14,374	17	10
Rents and insurances paid during the year but unexpired at this date				273	13	9
Bills receivable in hand				10,468	5	1
Cash in hand and at bank				596	16	11
Profit and loss—net loss during 12 months, as per profit and loss account	£69,281	16	4			
Deduct profit brought forward, as per last balance-sheet, £2,475. 6s. 1d.; less dividends on preference shares paid during the year, £1,492. 9s. 9d.	982	16	4			
				68,299	0	0
				£318,935	16	1

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Alfred Sohier Bolton, Esq., Sir Frederick J. Bramwell, Bart., F.R.S., G. H. Hopkinson, Esq., Granville R. Ryder, Esq., and R. W. Wallace, Esq.

Report of the Directors to be presented at the sixth ordinary general meeting to be held at No. 1, Great George-street, Westminster, on Thursday, the 16th February, 1893, at 5 p.m.

The Directors submit to the shareholders a statement of the accounts of the Company, together with a report of the position of the undertaking at the end of the year 1892. The mains, which extended for a length of 12½ miles in the previous year, have been increased during the year 1892 to 13 miles, and many of the existing mains have been increased in sectional area. During the year the number of houses and shops connected with the system has increased from 436 on the 31st December, 1891, to 550 on the 31st December, 1892; while the number of lamps calculated on the usual basis of 8 c.p. has increased from 38,408 to 47 441. The improvement in the efficiency of working the plant reported as being made at the last meeting has been maintained throughout the year. In view of the increase in the business of the Company from the present district, and in contemplation of the increase from the area mentioned in the next paragraph, the plant at Kensington Court and at Chapel-place has been extended, and further machinery is on order. Negotiations are pending, and, subject to the approval of Parliament, may be regarded as practically concluded, for the transfer to this Company of that portion of the parish of St. Mary Abbotts, Kensington, which is at present served by the Chelsea Electricity Supply Company, Limited. The transfer cannot be carried into effect without the sanction of Parliament, and the necessary Bill has already been approved by the shareholders in two successive meetings and has been introduced into Parliament. This transfer, if sanctioned, will add to the Company's area of supply an important district, which in the opinion of your Directors will materially improve the Company's position. The dividend on the 6 per cent. preference shares was duly paid to 30th June, 1892, and an interim dividend at the rate of 4 per cent. per annum was paid on the ordinary shares for the first half of the year, and out of the balance standing to the credit of the net revenue for the year 1892, £3,792. 13s. 5d., the sum of £1,462. 10s. has been appropriated for the payment of the preference dividend to the end of the year, leaving £2,330. 3s. 5d., out of which it is proposed to pay a further dividend on the ordinary shares at the rate of 4 per cent. for the past half-year, leaving a balance of £867. 13s. 5d. It will be observed that no provision has been made in the accounts for Directors' remuneration. In accordance with the articles of association, Mr. G. H. Hopkinson and Mr. Granville R. Ryder retire from the directorship, and being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. Whiffin, and Dickinson, offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1892.				£	s.	d.
Capital, 15,000 ordinary shares of £5 each............				75,000	0	0
,, 10,000 first preference shares of £5 each..				50,000	0	0
,, Mortgate debentures				29,400	0	0
Sundry creditors and open accounts				3,011	14	4
Renewal account, balance at credit thereof				2,063	5	0
Net revenue account				3,792	13	5
				£163,267	12	9
Cr.				£	s.	d.
Plant, buildings, mains, furniture and fittings, provisional order, and goodwill, at cost				146,804	16	5
Freehold and leasehold property	£5,713	3	11			
Less depreciation	300	8	0			
				5,412	15	11
Preliminary expenses and cost of debenture issue				842	3	6
Sundry debtors				6,859	7	0
Stock in trade and stores				379	9	4
Consols....................				549	3	10
Cash at bankers—Messrs. C. Hopkinson and Sons	£479	1	2			
Cash at bankers—London and County Bank..............	326	12	2			
Cash in hand.........	14	3	5			
				819	16	9
Suspense account (law)	1,800	0	0			
Less amount debited to law charges	200	0	0			
				1,600	0	0
				£163,267	12	9

Dr. REVENUE ACCOUNT, DEC. 31, 1892.	£	s.	d.
Manufacturing electricity, coal, oil, water, waste, wages, and sundries........	3,746	11	4
Repairs to leasehold property	12	15	0
Repairs to apparatus on consumer's premises	12	17	0
Incandescent lamps	117	18	3
Salaries	975	12	6
Miscellaneous expenses, including law charges......	895	5	3
Company's auditor	31	10	0
Board of Trade auditor, compulsory under provisional order.........................	59	0	0
Bad debts	393	6	9
Rent, rates, and taxes.............	898	18	3
Insurance	67	14	7
Renewal account in respect of buildings, mains, plant, batteries	3,395	15	7
Sinking fund, leasehold property............	103	0	0
Balance	6,828	7	8
	£17,538	12	2
Cr.	£	s.	d.
Sale of electricity (535,343 units)	17,773	8	4
Less rebates	1,144	14	2
	16,628	14	2
Rent of meters	577	17	11
Repairs to apparatus on consumer's premises	26	0	6
Sale and maintenance of lamps......................... ..	118	9	7
Rent receivable	185	0	0
Transfer fees	2	10	0
	£17,538	12	2

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Interest on temporary loans	11	14	0
Interest on debentures accrued due to date, less income tax	957	8	10
Dividend on 6 per cent. first preference shares and interim dividend at 4 per cent. per annum on ordinary shares to June 30, 1892 less income tax...	2,925	15	4
Balance	3,792	13	5
	£7,687	11	7
Cr.	£	s.	d.
Balance from last account	3,810	11	3
Less dividends on preference and ordinary shares to December 31, 1891	2,962	10	0
	848	1	3
Interest	11	2	8
Balance brought from revenue account	6,828	7	8
	£7,687	11	7

Dr. RENEWAL ACCOUNT.				£	s.	d.
Maintenance of buildings, mains, plant, meters, instruments, etc.				2,124	15	7
Plant written off	£1,371	0	0			
Less cash received for old material	450	0	0			
				921	0	0
Balance				2,063	5	0
				£5,109	0	7
Cr.				£	s.	d.
Balance from last account				1,713	5	0
Amount brought from revenue account				3,395	15	7
				£5,109	0	7

BUSINESS NOTES.

Great Northern Telegraph Company.—The receipts for the month of January were £20,800.

Western and Brazilian Telegraph Company.—The receipts for the week ended February 3 were £3,559.

Warrington.—Tenders are required for telephones at Warrington; apply to Mr. J. Lyon Whittle, town clerk.

Bloomsbury.—The Broad-street clock of the St. Giles's Workhouse, Bloomsbury, is to be lighted by electricity at a cost of £150.

Eastern Telegraph Company.—The receipts for last month were £60,516, as against £63,436 for the corresponding period of 1892.

Cuba Submarine Telegraph Company.—The receipts for the month of January were £282 more than for the corresponding period of 1892.

Dundee.—The boilers have been tested under steam for the Dundee installation. The actual opening will probably take place in three weeks.

Direct Spanish Telegraph Company.—The receipts for the last month show a decrease of £294, as compared with the corresponding period.

Prague.—Projects for an electric railway at Prague have been submitted by Bartelmus and Co., of Brünn, and Siemens and Halske, of Berlin.

Burnley.--The time for carrying out the Burnley electric lighting provisional order has been extended by the Board of Trade until June 4th.

West India and Panama Telegraph Company.—The receipts for the two weeks ended January 31 show an increase of £319 as compared with the corresponding period.

Telegraph Construction and Maintenance Company.—The directors recommend a dividend of 15 per cent. for the past year, 5 per cent. of which has already been paid.

Edmonton.—Mr. M. M. Coote, of Edmonton, has been appointed contractor for supplying the electric light in certain parts of the Strand Workhouse and Schools at Edmonton.

Dublin.—The Corporation engineers are pushing the electric light in Dublin. The leading streets look most brilliant. The mains are being laid in some of the small streets.

Plymouth Telephones.—The Water Committee of the Plymouth Corporation have accepted the tender of Mr. F. Dagger for the renewal of their telephone line between Hartley and Roborough.

Maidenhead.—A committee has been appointed, consisting of the Mayor and Messrs. Wilton, Cox, Withnall, and Budgen, to go into the question of improved lighting the town by means of gas or electricity.

Labuan Cable.—Active measures are being taken by the Eastern Extension Telegraph Company to lay additional cables at an early date connecting Manila with Labuan, and Labuan with Singapore.

Russia.—It is stated that the Russian Minister has under consideration proposals from the Paris Continental Edison Company to light the towns of St. Petersburg, Moscow, Odessa, Warsaw, Kieff, Tula, and Tver.

Machine Register.—We have received *Phillips's Monthly Machine Register* of new and secondhand machinery, published by C. D. Phillips, Newport, Mon., price 6d. It contains many entries of machine tools, boilers, and engines.

Victoria Electric Railway.—The Paddington Vestry have decided to insert a clause, if possible, in the Edgware-road and Victoria Railway Company's Bill to provide that there shall only be one generating station in the parish.

Personal.—Mr. Emile Garcke, having accepted the appointment of managing director to the Electric Construction Corporation, Limited, has resigned his seat on the Board of the Brush Electrical Engineering Company, Limited.

Worcester.—At the meeting of the Worcester City Council on Tuesday, in accordance with the recommendation of the Watch Committee, it was decided to complete the purchase of Powick Mills, on the Teme, for the purpose of electric lighting.

Bury.—It is currently reported, says a local paper, that, unless the Bury Corporation proceed immediately to give effect to their statutory powers with regard to electric lighting, an electric lighting company will apply for similar powers applicable to the borough.

City and South London Railway Company.—The receipts for the week ending February 5 were £956 against £824 for the corresponding period of last year, or an increase of £132. The total receipts for 1893 show an increase of £758 over those for the corresponding period of 1892.

Chelsea.—The Chelsea Vestry have postponed the consideration of the question of lighting the streets by electricity for three months. If the company which has control over that area does not shortly find capital, it is hoped that the Vestry will be in a position to buy the concern very cheaply.

Beckenham.—The clerk to the Beckenham Local Board reported at last meeting that he attended at the Board of Trade last week, and complied with all the formal requirements in connection with the Board's application for an electric lighting order. There was no opposition to the order, and in due course it may be granted.

Bristol.—Subject to confirmation by the Bristol Town Council the acceptance of their tender for supplying the electric light cables, Messrs. Siemens and Co. have arranged with Mr. Krauss to make the trenches in the streets for these cables. Something like five miles of trenching will have to be made, chiefly under the footways.

Organ-Blowing.—The Vicar of St. John's Church, Taunton, last Sunday before his sermon, said that he was sorry to announce that the electric company had given notice that no more power could be supplied for the blowing of the organ. Electricity has been used for blowing the organ for five years, and has given general satisfaction.

Hampstead.—The Electric Lighting Committee reported to the Hampstead Vestry last week that they had accepted the terms offered by Mr. Preece, F.R.S., for undertaking the preparation of plans and specifications in respect of the proposed installation under the Hampstead electric lighting provisional order. The report was approved.

Werrington.—A vote was taken at the last meeting of the Werrington Industrial School Committee to defray the cost of the installation of the electric light at Werrington Industrial School. The new light has now been in regular use for three months, and its advantages over the former mode of lighting by paraffin have been highly appreciated.

Newmarket.—At the fortnightly meeting of the Newmarket Local Board, the clerk read a letter from the electric light company again asking the Board to give their formal consent to the provisional order they were about to ask for in Parliament. After discussion, the clerk was instructed to say the Board would not give their assent to the order.

Rugby School.—In all probability within the course of the next few months Rugby School will have an installation of its own for the purpose of lighting the school premises and boarding-houses by means of the electric light. The scheme is not yet completed, but so far as can be gathered it is not proposed to extend the current to any other portion of the town.

Bolton.—An electrical engineer is wanted for the Bolton Corporation, to have charge of the construction of the central station intended to be carried out for the borough, and to have the management of such works when completed. Salary to commence with, £200 per annum. Applications to be delivered to the town clerk by February 22. The Corporation have decided to borrow £40,000 for their installation.

Burton.—The Health Committee of the Burton Town Council report that the way was now clear for inviting tenders for the electric light building. It was recommended that the necessary advertisements for the latter be issued. Alderman Lowe moved the adoption of the report, and said the committee were anxious to facilitate the loan, and hoped to be able to be in a position to supply the light by next winter. Councillor Morris seconded. The report was adopted.

Rochdale.—At the Rochdale Town Council meeting last week, Councillor Cunliffe said that in one of the local papers Mr. Albert Bright suggested the desirability of lighting the Town Hall with electricity after the decorations were made. Would the chairman bring the matter before the committee? The change would be a source of economy and of comfort. Alderman Schofield replied that that question had not been before the committee, but he would mention it to them.

Powderhall.—The Edinburgh Cleaning and Lighting Committee have been requested to obtain a dynamo and fit up an installation for electric lighting in stables and depôt at Powderhall. On the suggestion of the Lord Provost, it was resolved to ask the committee to submit a report on the subject in view of possible extension of electric light to the neighbouring houses. The question of transferring the powers to the Edinburgh and Leith Gas Commissioners is being considered.

Bournemouth.—The Bournemouth Roads Committee reported at the Town Council meeting that the electric lighting company asked for consent for the construction of underground chambers for electric apparatus. The committee recommended that consent should be given on condition that free lights should be provided. Councillor Hankinson said the consent should be given or withheld on its merits, and the light should be paid for in the ordinary way. The matter was again referred to committee.

Nelson.—The Nelson Gas Committee considered the report of the gas engineer last week on the subject of the electric lighting installation, and resolved that the gas engineer prepare a report and submit same to the next meeting, showing (*a*) what will present contracts cost; (*b*) by means of accumulators how many lights could be kept going with present engine power; (*c*) what further extension is required, and probable cost; (*d*) motors—cost and character, and advisability or otherwise of selling by meter.

Belfast.—At the last meeting of the Belfast City Council, the report of the Gas Committee mentioned that a letter had been received from Prof. Kennedy, dated the 30th ult., in which he stated that there was, owing to a number of circumstances, considerable difficulty in preparing a scheme of electric lighting for Belfast, but he trusted to have the report ready shortly. The Lord Mayor said the committee were doing their best, and hoped to have Prof. Kennedy's report before long. The report was passed.

Vulcanised Fibre.—Hard vulcanised fibre tubes are made in lengths of from 22in. to 24in., and of a thickness of shell not greater than about ½in. They cannot be made smaller than about $\frac{5}{16}$in. inside diameter, and the thickness of the tubes in the small sizes has to be proportioned to the diameter. They are rolled perfectly true and straight, both inside and outside, are very solid and strong, and have a fine finish. They are adapted to a great many uses in electrical work, and the demand for all sizes is rapidly increasing.

Lighting of London.—The St. James's Lighting Committee, at their last meeting, recommended that each member of the Vestry be furnished with a copy of the report issued by the Electricity and Public Lighting Department of the St. Pancras Vestry on the year's work of that Vestry's electric supply undertaking, and that the vestry clerk be authorised to obtain the requisite number of copies. Mr. Keevil agreed, and said that London was far behind third-rate continental cities in the matter of electric light. The recommendation was agreed to.

Sheffield Albert Hall.—Mr. Joseph Harrison, in moving the adoption of the report of the Albert Hall Company, at Sheffield, on Monday, said the past year had been very expensive. The Albert Hall had been redecorated throughout, the lighting of the building improved, and a screen erected behind the balconies. Complaint was made that the directors, in arranging for new lighting, had not introduced the electric light, but it was explained that the installation of this was so costly that the directors did not feel justified in experimenting in this direction.

Limehouse —At a meeting of gas consumers at Limehouse Town Hall last week, on the motion of Mr. Edward Smith, seconded by Mr. Beverley, it was resolved : "That this meeting of ratepayers hears with satisfaction that the Limehouse District Board of Works is pursuing enquiries as to the advisability of lighting the district with electricity." It was further decided to send a report of the meeting to the company, and a request to the Limehouse Vestry to communicate with the different vestries and local boards with a view to a conference on the future lighting of the metropolis.

Londonderry.—Tenders are required for the supply and erection of steam-boilers, steam-engines, condensers, steam and water pipes, water-tanks, electrical machinery and apparatus, arc lamps, lamp pillars, underground mains, etc., for lighting of streets by electricity for the Corporation. Copies of plans and specifications, prepared by Mr. Henry W. Blake, engineer, can be obtained from Mr. R. N. Chambers, town clerk, Guildhall, Londonderry, on and after 10th inst., on payment of £1. 1s. which will be returned on receipt of a bona fide tender. Tenders will be received for the whole or any item of the specification. Tenders to be delivered to the town clerk by March 1.

Brush Company.—The Directors of the Brush Electrical Engineering Company, Limited, have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent (the maximum which, according to the articles of association, can be paid as an interim dividend) on the ordinary shares of the Company, for the six months ended December 31, 1892, payable February 27, 1893. The transfer-books of the Company will be closed from the 13th to 28th inst., both inclusive. In view of the interest payable March 1, 1893, on the debenture stock of the Brush Electrical Engineering Company, the debenture stock transfer-books will be closed from February 20 to March 2, 1893.

Falmouth.—The Falmouth Lighting Committee reported at the Town Council meeting last week that the gas company had offered to supply and fix a 230-c p. lamp and pillar, and supply gas for it free of cost, the lamp to be fixed near the lower part of the Moor. Also that Mr. Coon, representing Veale and Co , electrical engineers, St. Austell, attended, and furnished the committee with information on the subject of electric lighting. They recommended that the surveyor send tracings of the borough showing the streets to Veale and Co., Messrs. A'Court and Rogers, and any other firms of electrical engineers who may ask for them. It was decided to accept the offer of the gas company, provided they would allow the lamp to remain and supply the gas for 12 months.

Barry Island Electric Railway.—At the monthly meeting of the Barry and Cadoxton Local Board, held on Tuesday, Mr. John Robinson, M.I C.E., presiding, the clerk (Mr. J. A. Hughes) reported that the 18th inst. was the last day upon which objections could be lodged in Parliament against the Barry Company's Dock, Railway, and Electric Tramway Bill. So far as the House of Commons was concerned, it was already practically too late to take any steps. Mr. J. C. Meggitt said the disputed points had been practically settled, with the exception of the one referring to the proposed closing up of the road leading from the Wenvoe Arms Hotel, at Cadoxton, to the Moors. Eventually, it was resolved to defer taking action in the matter until after the Barry Company's meeting.

Burton upon-Trent.—The Mayor, Aldermen, and Burgesses of the borough of Burton-upon-Trent, acting by the Council, invite tenders from competent persons for the construction and erection of the buildings required for the boilers, engines, dynamos, etc., at the proposed electric light works in Wetmore-road, in the said borough. Full particulars, and copies of the conditions, specification, and bill of quantities, with the form of tender, may be obtained, and the drawings viewed, on payment of five pounds (which will be returned on receipt of a bona fide tender, with the bill of quantities fully priced out) on application to the engineer, Mr. F. L Ramsden, Gasworks, Burton-on-Trent. Sealed tenders, endorsed "Electric Light Buildings," are to be delivered by 10 a.m. on Saturday, February 25.

Llandudno.—Mr. John Smith, of Craigside Hydro, Llandudno, last week gave a public view of his premises, which are replete with all the latest luxuries and requirements for the comfort of the inmates. A feature is the recent installation of the electric light by Mr. W. Kingsland at a cost of £2,000, and the average cost of the light, Mr. Smith explained, is £10 per week. The steam-engines are 60 h.p., and it is possible, with the appliances at command, to supply 600 lights. The usual number by which the place is illuminated is 400 lights. Mr. Kingsland gave an experimental lecture with a model electric tramway, which was much appreciated. The Town Commissioners were present, and the meeting may lead to steps being taken for the introduction of the light into Llandudno for the town-lighting.

Submarine Cable to Tunis.—The cable which is being laid down between Marseilles and Tunis is the second which has been made in France. It was commenced at St. Tropez, a small town near Toulon, on October 15 last, and was completed on January 3, having given occupation to 250 workmen and being 725 miles in length. This new cable, says the *Times*, which opens up direct communication between France and Tunis, brings the number of them up to 1,168, with a total length of 140 344 knots, and of these 1,168 cables 880 belong to the Governments of the countries which they connect and 288 to private companies. France, with 64 cables of 3,400 knots in length, owns more than any other Government so far as length is concerned, the 150 English cables being only 1,588 knots in length.

Whitechapel.—Mr. T. Catmur, L.C C., revived the question of electric lighting in Whitechapel at the District Board meeting on Monday, when he proposed a resolution instructing the Streets Committee to proceed practically, the Board having obtained the necessary provisional order from the Board of Trade. This is the first step taken towards the realisation of electric light for East London, and it will be gratifying to the opponents of the gas company to know that Mr. Catmur and his colleagues are not in any way afraid of the great responsibilities they have undertaken. Indeed, they confidently anticipate the future described by the Rev. C. Sales in his speech at the gas consumers' demonstration at the Limehouse Town Hall as that time "when the Commercial Gas Company shall be dead, with the pale light of electricity shining on its dingy tomb."

Chiswick.—The clerk reported at the last meeting of the Chiswick Local Board as to further communications with the Board of Trade concerning the agreement with Messrs. Bourne and Grant *re* the provision of the electric light in the district. It appeared, said the Clerk, that the agreement had been referred to the Council of the Board of Trade, who raised the question of the transfer of the contract to a limited liability company. Mr. H. Smith said he had seen Messrs. Bourne and Grant, and they seemed inclined to throw the contract up unless a speedy settlement were arrived at. Alderman Hardy said that the delay was not the fault of the Chiswick Board, but of the Board of Trade. The Clerk suggested that the chairman should be present at the meeting of the Council in relation to the matter, and Mr. Compton consenting, the matter dropped.

Heckmondwike.—The result of the poll of the ratepayers for and against the proposed introduction of the electric light into Heckmondwike by the Local Board has been declared, as follows: Against, 725 ; for, 694 ; majority, 31. At a largely attended and representative meeting of ratepayers, held in October last, a vote emphatically in favour of the introduction of the light was adopted by an overwhelming majority, and the promoters of the project have since been so sanguine of the ultimate adoption of their proposals that they have given the opposition every facility for analysing the researches they have made finally, and in face of the decision of the public meeting referred to yielded to a poll of the township being taken. The number of papers returned unfilled up was 523, showing that nearly one-fourth of the electors took no interest in the question either way.

Coventry Tramways.—A meeting of the General Works Committee of the Coventry City Council was held on Tuesday, Alderman Marriott presiding, when the town clerk submitted the draft of an agreement between the Corporation and Mr. W. S. Graff Baker, the owner of the tramway, which the latter had put forward as a basis for consideration. Under it Mr. Baker is to equip the tramways with electric traction upon the Thomson-Houston overhead wire system, to organise and maintain a reasonable and efficient service, to be open to the award, at the end of every five years, of an arbitrator. The Corporation are not to exercise for 21 years their powers of compulsory purchase under any Act of Parliament. The standards are to be of an approved design, and to be open to the Corporation to use for lighting by gas or electricity. The full consideration of the matter was adjourned.

Cost of Arcs.—Mr. W. Crowe questions Mr. Walker's figures at Cardiff on the comparative cost of arc and incandescents for public lighting. A 2,000 c.p. actual, taking 15 amperes at 60 volts, or 900 watts, at 6d. per unit gives 5½d., and ¼d. for carbons, 5¾d. per hour. To get the same light it would require eight 200-c.p. incandescents at 400 watts each, or 3,200 watts, at 6d., 1s. 7¼d. ; add 1¼d for lamp renewals and incandescents cost 1s. 8½d., or four times as much as the arc. Mr. E. Slater also comes to the rescue of arcs, and as to going out, says : "If it is an inherent fault of the system that the lights go out, why do the authorities impose fines for such occurrences? Simply because it depends on the engineer in charge what the behaviour of the lamps shall be. Engineers are only human, and it is astonishing how steadily lamps will burn if a fine per lamp per hour outlooms in the distance."

South America.—The following details are given of the electric lighting in the Argentine: Buenos Ayres has 60 arcs and 2,000 incandescents, and at the port 50 arcs; La Plata, public and private, 200 arcs and 800 incandescents, also electric railway; Rosario, private lighting with 50 arcs and 1,800 incandescents ; San Nicolas, 800 incandescents, public and private ; Sante Fé and Esperanza, the same; Adrogué, 700, and Areciferes, 400 incandescents ; San Fernando, 600 ; while Mercedes has for public and private lighting 1,200 incandescents at work. As a total, there are some 10,000 incandescents and 6,000 arcs in the Argentine Republic, to which may be added 2,000 incandescents in various mills and factories. The Mercedes station was supplied by Ganz and Co., of Budapest, on the transformer system; it is capable of running 3,000 lamps, and cost £8,000. The receipts are £400 a month, expenses £200; after taking off 6 per cent. for depreciation the installation yields 24 per cent. The price per 16-c.p. lamp is 7s. 6d. a month, but meters are being introduced, the price being fixed at ½d. per 16-c.p. lamp-hour. This price is considered low as compared with the price of gas in the district.

Maidstone.—With reference to a recent note on the lighting scheme for Maidstone, Mr. W. C. C. Hawtayne, the consulting engineer to the Corporation, informs us that the figures there given, taken from a local report, are not accurate. The total number of lamps to be provided for is 2,000. The maximum number of lamps in use at any one time is estimated at 1,300. For this plant 125,000 watts is provided, which allows nearly 50 kilowatts spare plant over the maximum supply. The number of units estimated to be sold during the year is 118,000 units, but the area lit really only comprises the three or four principal business streets of the town without any residential district which will be tapped later on. The compulsory area is very small. The system advocated is high tension, either direct or, preferably, alternating. The station will be placed at the sewage works, about a mile from the town—the object being to save labour by using the present sewage works staff during 16 hours of the day, and also to get higher ground to avoid floods. The price of gas at Maidstone is only 2s. 5d. per 1,000ft. Mr. Hawtayne estimates the cost of electricity at 6½d. per unit, the proposed charge as the equivalent of gas at 4s. 10½d. Mr. Hawtayne's report has been approved by the Electric Lighting Committee.

Proposed Cable for St. Helena.—Some time ago, in view of the depression felt amongst all classes, we (says the *St. Helena Guardian*) registered a vow that we would not cease to lift up our voice on every possible occasion, and upon every theme, likely to bring any benefit of a permanent description to the island. Agriculturally we are not finished by any means, or horticulturally, but there are yet one or two things on the old line we can advocate, one that will gratify the wistful gazers at the signal station, and the old style of agriculturists and gardeners. It is, as our heading indicates, a submarine cable telegraph to our nearest connecting point, Mossamedes. We have seen agitators (from the papers) by persistent and never-know-when-beaten perseverance gain their ends; why not, then, St. Helenas register a vow, one and all, rich and poor, high and low, to agitate for a cable, to send in a petition regularly as the quarter day comes round? Try, first of all, that powerfully just statesman who did so much for India, Lord Ripon; also the Queen, not in the second place, but in order that if information were asked the Crown Adviser would be prepared. Corporations of London and Liverpool, with their vast shipping interests, might be asked to co-operate, and also the Mauritius, Hamburg, Rotterdam, Marseilles, Calcutta, Rangoon, and the Cape, last of all, in the interest of its colonial defence.

West Calder.—In the Loganlea Colliery, now in the possession of Mr. John M'Culloch, extensive alterations and additions to the plant have been carried out, and altogether it is now one of the best equipped collieries in the East of Scotland. About a year ago an electric installation for lighting, hauling, and pumping was completed. The dynamo, motors, cables, lamps, and connections were supplied by Mr. Wm. M'Whirter, of the Faraday Electrical Works, Govan, and comprise a 70-h.p. Faraday compound-wound dynamo and two motors of the same type, three arc lamps of 2,000 c.p. each, and numerous incandescent lamps advantageously placed throughout the engine-rooms, pithead, screens, dross washing machine, the bottom of the shaft, and the entrances to the main roadways underground. The haulage is capable of dealing with 200 tons per day, and so satisfactory has the introduction of electricity proved that there is at present in course of erection another haulage to deal with a similar quantity. The pumping plant was specially constructed, and is of the triplex pattern and fitted with helical spur gearing. In order to thoroughly test the electrical and mechanical efficiency of this pump, it was run consecutively for nine weeks to the entire satisfaction of all parties, the amount of water delivered being about 270 gallons per minute. Messrs. Gibb and Hogg, Limited, Airdrie, supplied the drums, shafts, and gearing for the hauling plant, and were also the contractors for the triplex pump.

Leak Detector.—The *Review*, fire insurance organ, publishes a description of the leak detector invented by R. Wallis-Jones, which, by means of an ingenious switch put in by clockwork, periodically tests the leakage on any installation circuit. Two typical faults are mentioned to which the instrument called attention recently: "No. 1. It was found that there was a leakage on some little time ago, by bell ringing and lamp lighting, and on localising same by cutting off various circuits, we discovered that one of the lugs of the accumulators had warped while in use, and had just touched very slightly an iron bracket on which the upper shelf was supported; a screw securing this bracket made a very good earth connection. On bending back the lug, of course the fault was removed. No. 2. Only last week the attendant in charge was warned of a leakage by the bell ringing. On examining we found that occurred from a small portable accumulator which was being charged, and which has been leaking badly, the acid getting on to some damp stone flags, thereby being connected to earth, therefore forming a path for the leakage through the electrolyte which was spilt. We need hardly point out," adds the *Review*, "the advantage of having an automatic apparatus which is testing the circuit periodically, and warning the consumer when a leakage occurs." A detector of this sort is, of course, applicable only to isolated or self-contained plants, such as houses, hotels, and factories, and not to installations connected with central-station low-tension mains.

India.—Messrs. Ernest Scott and Mountain, Limited, of Close Works, Newcastle-on-Tyne, have recently supplied through their agents, Messrs. John King and Co., Limited, Telkulghat-road, Howrah, Calcutta, a complete installation of electric light for lighting a large spinning-mill. The plant consists of a vertical engine capable of giving 30 effective horse-power, the speed of the engine being controlled by automatic expansion gear, enabling any number of lights to be switched on or off as required, the engine maintaining a perfectly constant speed under varying loads. The dynamo is of Ernest Scott and Mountain's improved type—compound-wound—the machine being constructed to give an output of 120 amperes at an E.M.F. of 105 volts when running at a speed of 1,000 revolutions, and is capable of running 200 16-c.p. lamps easily. A main switchboard fitted with one of Ernest Scott and Mountain's improved double-pole main switches, with the necessary measuring instruments and fittings for 200 pendants were supplied, the lamps being suspended from the ceiling, and each lamp being provided with an opal shade. Cable, casing, and all other sundries required for the installation were also supplied, together with full instructions for fixing. Messrs. Ernest Scott and Mountain have made arrangements whereby they are able to send to their customers in the colonies, on receipt of particulars of the arrangement of lights, a complete plan showing the method of wiring and the size of each cable, so that customers ordering plant from them can erect the installation themselves with local labour, it only being necessary to accurately follow the plans of wiring, which are supplied without any extra charge to firms placing orders with them.

Scarborough.—At the meeting of the Scarborough Town Council last week, the minutes of the Electric Lighting Sub-Committee, who met on January 6th, were considered. This committee reported that they had received a letter from Colonel Steble asking the consent of the Corporation to the raising of the pressure of the electric supply from 1,000 volts, as at present arranged, to 2,000 volts, and they had resolved to recommend that the site proposed for the company's generating station be approved, and that the question as to whether the Corporation should consent to the raising of the pressure of the electric supply from 1,000 volts to 2,000 volts be referred to Mr. Bernard Drake, the electrical engineer of the Corporation, for him to advise thereon. The committee confirmed the minutes, with the exception of the one that the application from the Scarborough Electric Supply Company, Limited, that the pressure of their electric supply might be raised from 1,000 volts to 2,000 volts. At a subsequent meeting on January 26, the Sanitary and Lighting Committee considered the minutes of a meeting of the Electric Lighting Sub-Committee held on January 24, at which letters were read from Colonel Steble, Mr. Bernard Drake, and Mr. A. A. C. Swinton, with reference to the increase of the pressure of the electric supply, and they now adopted a recommendation to them from the sub-committee that their previous resolution refusing to agree to the increase of pressure be rescinded. Councillor Whittaker made a long speech to the effect that he had lost confidence in Mr. Drake, and he hoped they would not change, though he would not challenge a vote. Councillor Saunderson said he had written to one of the best authorities in London, who assured him there was no additional danger.

Edinburgh.—The Edinburgh Town Council on Tuesday remitted to the Cleaning and Lighting Committee a motion by Messrs. Hunter and Cubie to consider and report as to whether there should be public electric lighting, and if so, for what streets it would be adopted, with the view of better enabling the Council to estimate what power would be required, and the system which would be most successful. Mr. Kinloch Anderson, in support of a motion by himself and Mr. Waterston to remit to the Lord Provost's Committee to consider and report as to whether the powers under the electric lighting provisional order, 1891, should be transferred to the Edinburgh and Leith Gas Commissioners, said that the Corporations of Edinburgh and Leith had entered into co-partnership in forming the Gas Commission—so constituting them the lighting authorities for the district—and if the Edinburgh Corporation entered into business to supply electric light practically in opposition to the Gas Commissioners, or transferred their right to a company, they would violate the spirit of the co-partnery. They were, therefore, morally bound to offer the transfer of the provisional order to the Gas Commission, whether or not that body might think proper to accept it. If they handed it over to a company, as the electric light succeeded, the interests of the Gas Commission would be seriously affected. Gas would increase in price, and the citizens who could not afford the luxury of the electric light would be compelled to pay dearer for gas. The Commissioners were likely to introduce the electric light more economically than the Corporation itself. There were certain companies applying for that order. One company in particular had made application. Their shareholders were not philanthropists; they were a body who desired to earn dividends. Mr. Waterston seconded the motion, which was passed.

Blackpool.—Major-General H. Darley Crozier, R.E., conducted a Local Government Board enquiry at Blackpool last week respecting the application of the Town Council to borrow £26,000 for electric lighting. The town clerk (Mr. J. Loftus) quoted statistics showing the increase in the population and rateable value during recent years, the latter having increased £111,000 in 16 years. He argued that many of the new companies, besides the public companies, tradesmen, and hotel proprietors, would take electricity in preference to gas. The borough surveyor and electrical engineer explained the plans which were submitted. Councillor J. Pearson, chairman of the Electrical Lighting Committee, said the question had been carefully considered, and the committee thought it most desirable for a seaside resort to have the electric light. They had recommended that it be provided for the promenade and for the centre of the town, and had no hesitation in saying that it would be largely taken up by the tradesmen and others in the town, which was more progressive than many others. The Mayor (Alderman J. Cardwell) concurred with all that Mr. Pearson had said, and expressed the opinion that the light was desirable both for the public streets and private consumption. Dr. Hardman asked for figures showing how possible losses would be provided for, but was told that there was little danger about the venture proving a failure. In Newcastle it had been supplied at 4½d. per unit, less 10 per cent. in some cases, and the Post Office had had it for 3·6 unit. Although this exceedingly low price had been charged, a profit of 4 per cent. had been paid on ordinary shares, and 6 per cent. on debenture. Mr. Councillor Sergenson, who paid nearly £200 per annum for gas, said he should prefer to have the electric light. The Royal Palace Gardens Company will also take it, and the New Tower Company would probably become customers instead of generating their own electricity, as had been suggested.

Hastings.—At the last meeting of the Hastings Town Council, the Mayor had given notice "to call attention to the desirability of lighting the Town Hall and the Brassey Institute with electric light, and to move that the matter be referred to the Public Lighting Committee for consideration and report." Dr. Croucher remarked that he brought forward this motion on the score that it was obvious that to work in a place which was lighted by electric light was far more healthy than to work in a place lighted by gas. With regard to the Brassey Institute, it was well known that all the rooms were more or less dark. Even in the entrance hall, he believed, there was never a ray of sunlight. There was no doubt that on the score of health, comfort, and economy they would gain considerably by having the electric light, but beyond that he considered they were behind the times not to have electric light in those buildings. Councillor Duke seconded, and said in advocating the electric light he did not do so under any circumstances in opposition to the gas company, but because he knew by personal experience what the electric light was. Ever since he had had it in his own establishment, he had known how very superior was the air of the place, and he was confident, if the Mayor's proposal was carried out, the result would be everything that could be desired, and they would find the electric light far beyond the gaslight. Of course, it would come to the question of cost, which would come before the committee. Leaving that question out for a moment, there was not the slightest doubt that the electric light was far superior for the purpose. He had a letter from Mr. W. V. Crake, who was interested largely in the Hastings and St. Leonards Museum, which was located at the Brassey Institute, and who expressed himself pleased that the Mayor's proposition was about to be brought forward, hoping that it would be carried, more particularly so far as it concerned the museum, because articles exposed there were affected by the action of the gas. The electric light, Mr. Crake said, would be far superior to gas in the museum. The motion was agreed to.

Glasgow.—Mr. Ure, in moving the adoption of the Gas Committee minutes at the last Glasgow Town Council meeting, asked for an authoritative statement as to the position of the works, and the progress that was being made with the electric lighting. Mr. Burt, in seconding the motion, said that, so far as the works were concerned, they had got along successfully. He admitted the delay had been greater than was anticipated, but that to a large extent had been impossible to get over. As far as the incandescent light was concerned, they were now in a position to supply any number of regular customers. All that required to be done was to connect the houses with the mains from the stations. Of course, it was not reasonable that they should rush on with that, seeing that they were supplying the customers with current from the high-tension station, but when the connections were made with the new stations, the old station would be closed. As far as the street-lighting was concerned, the delay had been caused in some measure by the Watching and Lighting Committee not getting the pillars erected. At the station the engines were now in their places, and the dynamos would be also there in a few days, and the committee expected to be able to turn on the current for the street-lighting as soon as the lamps were in position. The number of lights at first would be slightly in excess of what had been stated, for he expected that George-square, as well as Sauchiehall, Renfield, Union, and Jamaica streets would be lighted. They would be also in a position to light Argyll-street were it not that the operations of the railway company prevented them getting the lamps erected. He expected that before the end of the month, and perhaps earlier if the lamps were all erected, they would be in a position to light these streets with electricity. Mr. Gray thought that Mr. Burt should not have extended his remarks to the Watching and Lighting Committee. There had been no delay on the part of that committee. There had been some delay in connection with the laying of the stones for the lamps, but the committee were not responsible for that. The minutes were approved.

London County Council.—The Highways Committee report that they have considered two notices from the London Electric Supply Corporation, the one dated January 17, 1893, of intention to lay distributing-mains in London-road, Southwark Bridge-road, and Newington-causeway, and the other, dated January 19, 1893, relative to similar proposed works in Eaton-square, place, and terrace, and Cleveden-place. The mains will in each case consist of concentric lead-covered cables drawn into cast-iron pipes, and they see no objection to what is proposed. The traffic in Newington-causeway being very large, they are of opinion that the interference with it should last for as short a time as possible, and that therefore the works in the thoroughfare should be carried on continuously until completed. They recommend that the sanction of the Council be given to the works referred to upon the following conditions: That the company do give two days' notice to the Council's chief engineer before commencing the works, in the carrying out of which only one side of any thoroughfare shall be obstructed at one time; that the works in Newington-causeway, when once commenced, shall be carried on continuously by day and by night until completed; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that no pipes of larger size than 5in. shall be used; that no street boxes shall be constructed until the positions for and the mode of construction of them shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering. They have also considered a notice from the House-to-House Electric Light Supply Company, dated January 19, 1893, of intention to lay mains in Earl's Court-road, from Richmond-road to Earl's Court-square, and a further notice, dated January 24, 1893, from the same company relative to proposed extension of mains in Gloucester-road from Old Brompton-road to near the north side of Hereford-square. In each case the mains will be laid in 3in. cast-iron pipes; and they see no objection to the proposed works. They recommend that the sanction of the Council be given to the works referred to. A notice has been given by the Westminster Electric Supply Corporation of intention to lay mains on the north side of Aldford-street, Mayfair. The proposed works appear to be unobjectionable, and they recommend that sanction be given. The City of London Electric Lighting Company has given a notice dated January 24, 1893, of intention to lay mains with the necessary street boxes (under the Southwark Electric Lighting Order, 1891) on both sides of Blackfriars Bridge, along Blackfriars-road (part of), Southwark-street, John-street, Holland-street, across and along Bankside, Great Guildford-street, Park-street, Southwark Bridge (east side), and across and along a part of Southwark Bridge-road. The particulars furnished by the company are insufficient, and it has been asked to supply further details. In order that the works may not be proceeded with before the Council is in possession of the proper information, the Highways Committee recommend that the Council do formally *disapprove* the works referred to in the notice dated January 24, 1893, of the City of London Electric Lighting Company.

Portsmouth.—The following report of the Electric Lighting Committee was presented to the quarterly meeting of the Portsmouth Town Council held on Tuesday: "Your committee submit the tenders received for the three sections of Contract No. 2 in connection with the electric lighting scheme. Section No. 1 comprising boilers, engines, etc.; section No. 2 dynamos, transformers, etc.; and section No. 3 turbine alternators:

	Section No. 1.	Section No. 2.	Section No. 3.	General
Electric Construction Corporation	£15,441	£8,652	—	—
Brush Electrical Company	15,850	9,360	£1,750	£26,960
Willans and Robinson	18,086	—	—	—
Do. (alternative)	18,276	4,285	—	—
S. Z. de Ferranti, Limited	18,094	11,618	1,750	31,462
Do. (alternative)	17,794	11,118	1,550	30,462
Do. (alternative, combined plant)	—	—	—	31,250
Do (alternative, combined plant)	—	—	—	34,510
Hammond & Co. and Fowler & Co.	16,906	10,691	1,876	29,250
Do. (alternative)	17,721	—	—	—
Do. (alternative)	15,640	—	—	—
G. E. Bellis and Co.	21,500	—	—	—
J. G. Statter and Co....................	16,671	9,787	2,060	27,890
Siemens Bros. and Co.	—	8,644	—	—
H M. Leaf	—	13,500	—	—
Fullerton and Co......	14,500	—	—	—
Yates and Thom	14,280	—	—	—
Sharp and Kent	16,875	—	1,835	—
C. A. Parsons and Co.	—	—	1,750	—
Carrick and Wardale..................	13,570	—	—	—
Laing, Wharton, and Down Construction Syndicate	—	11,127	—	—
Johnson and Phillips	—	9,347	—	—
James Watt and Co.	13,780	—	—	—
Drake and Gorham	—	11,910	1,855	—
Latimer Clark, Muirhead, and Co.	14,484	8,654	1,837	24,976
Daniel Adamson and Co.	16,050	—	—	—
Julius G. Neville and Co.............	Not on form of tender.			

Your committee considered carefully the whole of these tenders, although some of them were, in fact, variations from the specification, and the whole of the tenders were referred to the engineers for their consideration and advice. Your committee were at first disposed to recommend the acceptance of Messrs. Yates and Thom's tender for Section 1; that of the Electric Construction Corporation for Section 2; and that of Messrs. Parsons and Co. for Section 3; but it will be seen that Messrs. S. Z. de Ferranti and Co. submitted an alternative tender for direct-running plant, which provided, however, for a much larger output than had been contemplated, and they then submitted a proposal for a reduction in the plant and a co-operation with Messrs. Yate and Thom, as the makers of the engines and boilers proposed to be recommended, which appeared to offer many advantages. This proposal was therefore further considered, and the engineers were again consulted, and they have pointed out that there are many advantages which will accrue from the adoption of this latter suggestion Under it the total price for Sections 1 and 2 will be £21,780, and it will therefore be seen that this sum will be £434 below the total of the lowest tenders for Sections 1 and 2, apart from the question of whether the joint tender would be more advantageous in other respects. The engineers, however, report that there will be great economy in space in the engine-room, a reduction in the number of machines requiring supervision, a considerable saving in fuel, an increased output at present, and a saving in capital upon the tenders which it was at first proposed to recommend of £1,152. Under these circumstances, and bearing in mind the advantages which, as stated, will accrue from the tender of Messrs. Yates and Thom, and Messrs. S. Z. de Ferranti and Co. for Sections 1 and 2, your committee recommend that such tender be accepted at £21,780. Your committee also recommend that the tender of Messrs. Parsons and Co. for Section 3 be accepted at £1,750. Your committee submit a certificate from Messrs. Waller and Manville for payment to the contractor for the erection of the electric lighting station in Gunwharf-road, of the sum of £240, on account of the work executed, and recommend that such amount be paid. The report was adopted.

PROVISIONAL PATENTS, 1893.

JANUARY 30.

2010. **Improvements in electricity meters, worked from a central position.** William Harding Scott, Gothic Works, King-street, Norwich.

2044. **Improvements in mechanical pianos or other musical instruments worked by electricity.** Sir David Lionel Salomons, Bart., 1, Queen Victoria-street, London.

2059. **Improvements in or relating to telegraphy.** Albrecht Heil, 323, High Holborn, London. (Complete specification.)

JANUARY 31.

2134. **Improvements in porous vessels or pots and diaphragms for secondary and primary batteries.** George Lentz, 28, Southampton-buildings, Chancery-lane, London.

2145. **Improvements in dynamo-electric machines.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell and Edward Hibberd Johnson, United States.) (Complete specification.)

2159. **Improvements in or connected with electric arc lamps.** John Henry Rose, 166, Fleet-street, London.

2161. **Heating liquids by electricity.** Leslie Bradley Miller and Maurice Walter Woods, 2, Gray's-inn-road, London.

2167. **An improved apparatus for registering telephone calls.** Ludwig Kahn, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 1.

2182. **Improvements in apparatus for transmitting movements or indications by electricity.** Thomas O'Brien, 6, Bank-street, Manchester.

2191. **Improvements relating to telephone transmitters.** Henry Alfred Charles Saunders and Alfred Charles Brown, 124, Chancery-lane, London.

2198. **Improvements in balances.** William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

2199. **An instrument for the measurement of electric currents.** William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

2202. **Improvements in photographic printing by electric light and in apparatus therefor.** James Eglinton Anderson Gwynne, Brooke-street, Holborn, London.

2203. **Improvements in alternating-current arc lamps.** James Eglinton Anderson Gwynne, Brooke-street, Holborn, London.

2242. **Improvements in electric cooking or heating apparatus.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

2267. **Improvements in the method of and apparatus for the electrolytical separation of the bases of salts, and of compounds of the same from saline solutions.** Claude Theodore James Vautin, 1, Queen Victoria-street, London.

2272. **Improvements in electric light hangers or supports.** Herber Luther Holt, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 2.

2280. **Electric toy.** John Désiré England, 21, Charles-street, Royal-crescent, Notting Hill, London.

2311. **A new or improved apparatus for the electrolysis of saline solutions.** James Ballantyne Hannay, Whitehall Club, Parliament-street, London.

2318. **Electric tool.** George Henry Williams, 52, Chancery-lane, London. (Complete specification.)

2320. **Electro-chemical cementation for separating copper from solutions by means of iron.** Raimondo Conedera, 52, Chancery-lane, London.

2329. **Improvements in the manufacture of white lead electrolytically.** James Charles Richardson, 6, Bream's-buildings, Chancery-lane, London.

2331. **Improvements in secondary electric storage batteries or accumulators.** Nathan Huntley Edgerton, 70, Chancery-lane, London.

2334. **Improvements in electric incandescent lamps.** Ernest Bailey and George Mortimer Gordon, Broad-street House, Old Broad-street, London.

2361. **An improved depolarising material for galvanic elements.** Franz Szymanski, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 3.

2375. **Improvements in and relating to insulating supports for electrical conductors.** Alfred Rosling Bennett, 22, St. Alban's-road, Harlesden, London.

2381. **Improvements in and relating to ships' telegraphs.** John William Ray, 8, Canning-place, Liverpool.

2402. **Improved electrical alarm for use in connection with steam-gauges.** Ardeshir Tamuljee Mirza, 70, Deansgate, Manchester.

2403. **Improvements in the means of distributing electrical energy and in dynamos and other apparatus therefor.** John Augustine Kingdon, 29, Marlborough-hill, St. John's Wood, London.

2455. **Improved friction coupling for the carbon feed mechanism of electric arc lamps.** Joseph Jergle, 151, Strand, London. (Complete specification.)

2463. **Improvements in, and apparatus for, the electrolysis of solutions of salts or compounds of the alkalies, more especially intended for the manufacture or production of alkalies and chlorine, and for bleaching.** Julius Marx, 47, Lincoln's-inn-fields, London.

FEBRUARY 4.

2494. **Improvements in telephone enunciators.** Alfred Whalley, Mount View, Helsby, near Warrington. (Complete specification.)

2520. **Improvements in apparatus for automatically indicating and registering the score obtained in electric target practice.** Alexander James Eli, 76, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

20413. **Electrolytic apparatus for making caustic soda, etc.** Bamberg. (Second edition.)

1892.

2312. **Electric lamps.** Drake and others.

4190. **Electrical batteries.** Laurent-Cély and Finot.

4248. **Arc lamps** Brockie.

4429. **Switchboard systems for telephone exchanges.** Kingsbury. (Western Electric Company.)

4768. **Electric batteries.** Maquay.

8987. **Secondary batteries, etc.** Germain.

15994. **Electrical conductors.** Holmes.

19061. **Electric railway system.** Irish.

20693. **Electric arc lamps.** Hansen.

20989. **Electric light bracket.** Upcraft.

21273. **Electric contact-breakers.** Ethridge.

21621. **Incandescent electric lamps.** Von Mito.

21639. **Secondary batteries.** Kroeker.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	$2\frac{7}{16}$
City of London	—	12½
Electric Construction	10	2¾
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4½
London Electric Supply	5	¾
Metropolitan Electric Supply	—	6¾
National Telephone	5	$5\frac{5}{16}$
St. James'	—	8
Swan United	3½	$3\frac{5}{16}$
Westminster Electric	—	5⅞

NOTES.

Fraud.—Frederick H. Whipple, of "Whipple's Reports," has been convicted of fraudulent issue of drafts.

Institution.—On Thursday next, the 23rd inst., Mr. W. M. Mordey will read his paper, "Note on Testing Alternators."

Carpenters' Hall.—Prof. Silvanus Thompson will lecture at the Carpenters' Hall on "Electric Lighting" on Wednesday, March 1st.

Appointments.—An advertisement appears elsewhere for a superintendent engineer, to take charge of high-tension station; also for a draughtsman to electrical engineers.

Utilising the Thames.—The Windsor Waterworks Committee have recently had an interview with Mr. Liardet anent his new water turbine, for use in shallow falls, as seen in use at Cowley Old Mills, where 20 h.p. are obtained. Windsor is unable to make use of the water power at present, but Eton and Slough are spoken of as possibly likely to attempt to utilise their natural resources.

Swindon.—The Swindon New Town Local Board are inviting, by advertisement, tenders from companies or firms to undertake the electric lighting. Plans and particulars can be obtained of the surveyor, Swindon, or of Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster. Tenders must be sent in, giving terms, system, and conditions of purchase after given period, by May 1 next.

Windsor Castle.—The small engine and dynamo which have hitherto supplied such electric light as has been allowed in Windsor Castle have recently been removed, and replaced by a Davey-Paxman 50-h.p. engine and a Brush dynamo of proportionate size, which have been at Buckingham Palace for some time past, and have been worked there to a slight extent. The change is suggestive of extension in the lighting of the Castle.

Lecture.—At Shaftesbury Hall, Leeds, Prof. Stroud, of the Yorkshire College, lectured on Monday to an appreciative audience on the electric light. With the aid of lantern slides Dr. Stroud explained how currents of electricity are produced in a dynamo, and explained the working of various kinds of dynamos. He gave illustrations of the effect of the heat generated on different kinds of metals, and described how the various kinds of lamps are made and used.

Cantor Lectures.—The fourth and last lecture on "The Practical Measurement of Alternating Currents," by Prof. Fleming, will be given next Monday before the Society of Arts, dealing with: alternating-current ergmeters; meters for energy—Shallenberger, Thomson, Brillé, Frager, Ferranti; meters for quantity—Mengarini, Richard, Frager; watt-hour meters on high-tension primary circuits; methods of measuring total output of alternating-current stations; efficiency of supply; conclusion.

Pontypool.—Messrs. W. Jones and Son, Newport, contractors for the Pontypool central station, have begun building the station. The town will, in all probability, be partially lighted by the end of May. All the principal shops are together, and the total length of mains required for them is only 600 yards, and the company have already been promised 1,300 lights, which is rather more than two lights per yard. About four-fifths of the share capital has already been taken up. The electric contractor is Mr. Howell, of Llanelly, who is one of the directors and a large shareholder.

Burglar Alarms.—A determined attempt at burglary in the shop of Messrs. Walter Cross and Co., jewellers, Holywell-street, was thwarted early yesterday morning owing to the fact that when the burglar had effected entrance into the premises, he set ringing a "burglar alarm," the sound of which was conveyed by telephone to the residence of one of the members of the firm, who at once informed the police. The shop was speedily surrounded by constables, but the thief had taken fright and made off, without, however, securing any booty.

Automatic Safety Lampposts.—We described some time ago the new type of lampposts for the City lighting, in which the movement of a handle actuated a bar running up the post, throwing out the projecting bars which form the steps of a ladder, up which the trimmer climbs. This handle, in the latest type, has now been made to also actuate the arc lamp switch. The arrangement has the very definite advantage of making the lamp perfectly safe for the attendant. It is impossible to climb the post without cutting off the current. These ladder lamp-pillars were introduced by Messrs. G. Smith and Son, of the Sun Foundry, Glasgow, and seem to have proved their usefulness. The addition of the safety arrangement should serve to make them the standard type of arc lamp-pillars for public street-lighting.

Phosphorescent Photometric Standard.—At the Académie des Sciences on January 16, M. Becquerel presented some notes by M. Charles Henry on "Phosphorescent Sulphide of Zinc considered as a Photometric Standard," and on "The Minimum Perceptible Illumination." According to his researches, within very wide limits, and consequently in conditions easy to realise, which correspond to luminous saturation, the quantity of light emitted by phosphorescent sulphide of zinc at any given instant is independent of the distance of the magnesium flame, independent of time of illumination, and independent of the thickening of the coating of sulphide; in a word, sulphide of zinc when phosphorescent presents to the highest degree the characteristics required for a secondary photometric standard. M. Charles Henry has then applied the law of loss of luminosity of sulphide of zinc to the determination of the minimum illumination perceptible, which he finds equal to 29×10^{-9} candle at one metre.

Bronze Telegraph Wires.—A peculiar effect in telegraphic work is noted by E. Buels in the *Journal Télégraphique*, an abstract of which is given in the *Journal* of the Institution as follows: "Bronze wires were first brought in for telephone work, and were found a great improvement. When the author first tried them for telegraph work on a long Belgian line, he found that they were subject to a peculiar fault. He had two parallel lines across Belgium in the main Paris-Berlin route. These both usually worked Hughes satisfactorily. At times, however, he found the two lines affect each other very badly, but then one could be worked Morse and the other Hughes. The interference occurred only in dry weather, and towards the middle of the day—not at all on damp days. After much trouble, the author found that the fault was due to static induction, which was counteracted in iron wires by inductance, but the inductance in the bronze wires being so much less allowed it to show itself. The fault was much decreased by using Van Rysselberghe apparatus, which partially restored to the line the inductance that it lacked."

Units.—We give this week the suggestions of the Committee for the Electrical Congress at Chicago. M. Hospitalier, in *L'Industrie Electrique*, congratulated the committee on the happy idea of opening the discussion in the journals and finishing it only at the congress. He waxes very wroth, however, over some of the terms proposed, especially the word "voltage," which has become more or less accepted in English-speaking countries for electrical pressure or difference of potential. It is sought to give the sanction of the congress to this term. M. Hospitalier thinks it should not be admitted for one instant, or it will be necessary to sanction the terms "amperage," "ohmage," "wattage," and "joulage," as synonymous of current density, resistance, power, work, etc., which would be "*tout simplement absurde.* Science must create a language and not a slang." Here we have the recommendations of the committee as to discussion fully justified. The discussion is opened, though as yet, perhaps, on minor points. It is evident that the congress ought not to waste its time on too debateable or "simply absurd" recommendations, if such there be. Those that wish to increase, change, or slaughter the units must gird their loins for the fray, discuss decorously, and abide by the decision of the majority, or the best argument.

Communication with Lighthouses.—The first report of the Royal Commission appointed to enquire into the desirability of connecting certain lighthouses and light-vessels with the telegraphic system of the United Kingdom by electrical communication, has just been issued. The Commission recommends that the Goodwin (North Sand Head), Kentish Knock, Shipwash, Harborough, and Scarweather light-vessels be immediately connected by telephone. The Commissioners also recommend for immediate connection the Gunfleet pile lighthouse, which stands on the south-east part of the Gunfleet Sand, and commands a view over a great part of the Sunk and Long Sandbanks, and that electrical communication by aerial wires be established in connection with the following lighthouses—viz., Hart Point, Anvil Point, Needles, Orfordness, Girdleness, Nors Head, Cantick (Orkney), Mull of Cantyre, Corsewull (Stranraer), Mull of Galloway, Douglas Head, Point of Ayre, Nash, Bull Point, Hartland Point, Minehead (Dungarvan), Hook Point (Waterford), and Bailey (Howth). Of these, Bull Point and Hartland Point have already been connected by telephone with the coastguard line. It is also recommended that the Tuskar Rock lighthouse and the lighthouses on the islands of Caldy and Lundy be connected with the mainland by means of continuous cables. It is thought that the Fastnet Rock lighthouse would be the best adapted for further testing the system of communication by a non-continuous cable, and that it would prove a valuable station for giving notice of disabled vessels and communicating storm warnings, and the Commission recommend that this lighthouse should be selected for the experiment.

The Junior Engineering Society.—At a meeting of this society, held at the Westminster Palace Hotel last Friday, Mr. S. Boulding in the chair, a paper on "The Application of Small Electric Motors" was presented jointly by two members—Mr. Douglas Heap, M.I.Mech.E., and Mr. Arthur Heap, Stud.I.E.E. After giving an account of the several types of motors in general use, and the purposes for which they were specially adapted, the authors described the various systems of gearing, in connection with which parohide leather was mentioned as a material which had been satisfactorily applied in the manufacture of belts, ropes, twist, bevel, gear, and pinions. The requirements of the several electric power supply companies in regard to the use of motors were tabulated, and the simple arrangement introduced by Mr. Baron, manager of the St. Pancras central station, for supplying current to electric motors during the day time, at the cheap rate of 3d. per Board of Trade unit, was explained, the great advantages of the device both to the supply company and to the consumers being pointed out. The paper next dealt with mechanical and electrical tests which the authors had made, the results of running actual plants being given, showing their cost and efficiency. These included tests of an electric capstan, saw-mill, hoist, and other machines where small electric motors were applicable. Special appliances were next considered, including the electric riveter of M. Piat, and Mr. Rowan's electromagnetic drilling machine. Attention was drawn to the working facilities of such tools as compared with those of the ordinary kind, in ship and bridge building, and for other constructional purposes of a similar nature. In conclusion, some of the general precautions to be observed in running small plants were referred to, and the methods of coupling up the mains to the motor were described. Some of the motors, together with other specimens, were exhibited to the meeting. An animated discussion followed the reading of the paper—Messrs. H. B. Vorley, Callow, A. H. Dykes, B. H. Joy, A. Williams, W. B. Clarke, A. W. Marshall, W. J. Tennant, and others taking part.

Electrical Railways.—Dr. E. Hopkinson's paper on "Electrical Railways," before the Civil Engineers on Tuesday, dealt almost entirely with the working of the South London line. Figures as to cost of working were given which will be read with great attention by those who can obtain the paper, dealing as they do with one of the largest enterprises of this kind at work in Europe. The engines average 230 indicated horse-power each, or only one-half of full load; and they consumed 27½lb. per indicated horse-power hour, as compared with 22lb. at half load, obtained with Willans high-speed engines. The combined efficiency of engine and dynamo is 78 per cent. at full, 70 per cent. at half load, and 65 per cent. at quarter load. They consume 8·04lb. of North Country coal per Board of Trade unit. With average load the loss in long feeders is 5·7 per cent., and in distributors 3·5 per cent., a total of 9·2 per cent., say 10 per cent., equal to 1½ tons of coal per day, which exactly comes to the interest on £7,000—the actual cost of conductors. The coal burnt is 35 to 40 tons a day. The electrical efficiency of the system over all is 62 per cent., and the average efficiency of locomotive 70 per cent. The total cost of running is 5·1d. per train mile without wages, as against 6·3d., the total guaranteed cost, or less by 20 per cent. than the guarantee, and this though the trains are 30 per cent. heavier. In additional tables the details of cost to December 31, 1892, were given: Train mileage, 214,417; number of passengers, 3,317,602. Cost of generator station working, including renewals and repairs: wages, 1·12d.; fuel, 2·42d.; water and gas, 0·28d.; oil and stores, 0·41d.; repairs, 0·36d.; a total of 4·59d. per train mile, or equal to 1·56d. per Board of Trade unit. The cost of locomotive working, including repairs, was: generating station, as above, 4·59d.; wages, 1·98d.; oil and stores, 0·10d.; repairs, 0·23d.; total, 6·90d. per train mile. The figure 1·56d. per trade unit will interest central-station engineers, as it is the lowest of any generating station, save Bradford, which generates at 1·41d. per trade unit, but using cheaper coal; at Pall-mall the cost is 2·26d. Dr. Hopkinson justifies the use of jockey pulleys, mathematically showing that, when the speed of displacement travelling by wave motion forward is exactly equal to the speed of belt, there is very little loss of friction; and this condition is secured with a link belt running at 3,500ft. per minute, with a tension of 1,600lb., and weighing 8lb. per lineal foot. As to use of locomotive, the weight is four tons of frame and six tons of motor; the motors, if separate, would have to be heavier in total, and the car frames would have to be made heavier—there might be a saving of two tons, 1 per cent. or 2 per cent., an advantage, thought Dr. Hopkinson, greatly outweighed by having the motors on one vehicle.

High and Low Tension Systems.— Perhaps the most interesting part of the discussion on Dr. Fleming's paper on alternate-current transformers was in his own reply last week, where the professor was lost in the contractor for a while, and hard figures were slung at his opponents. Dr. Fleming takes the all-day work of a transformer on a 10 per cent. load, through the 24 hours, as 11 hours at 0 load, 5 at $\frac{1}{8}$th, 4 at $\frac{1}{10}$th, 3 at $\frac{1}{4}$th, and 1 at $\frac{3}{4}$th of full load, equivalent to 2·5 hours at full load, very nearly 10 per cent. He first compared the energy in watt-hours going into the primary at these various loads with that given out at the same loads: this for a "Hedgehog" and a "Mordey" respectively, and calculated the loss in current to be greatly in favour of the latter. But it was when comparing a 24-kilowatt transformer on double $^{7}/_{16}$ primary one mile long, with a three-wire feeder system one mile long, giving a maximum supply of 24 kilowatts at 200 volts at the further end, that the interesting part was reached. The transformer is supposed to have 1·35 per cent. loss on open secondary, plus 1·6 per cent. at full load: this gives open-circuit loss of 324 watts and an efficiency of 86 per cent. at $\frac{1}{10}$th load, and of 96 per cent. at full load. Calculating out the energy balance-sheet, the received watt-hours are 68,734, against 60,000 watt-hours delivered in the secondary circuit: the total $(C^2 R)$ losses in primary on same loads amounted to 346—total loss in 24 hours, 8·734 + 0·346 = 9·08 trade units, giving an all-day efficiency of 87 per cent. Now the cost of cable obtained "from responsible people" was given by Prof. Fleming for primary $^{7}/_{16}$, one mile, go and return, 4 ohms resistance, vulcanised, taped, and braided, in pipes with junction-boxes (but without trenches), with 24-kilowatt transformer, as £465. Three-wire feeders to give the same with 40 per cent. drop, Callender's bitumen steel-armoured cable (also exclusive of opening and making good trenches) complete, was £925. The figures have been checked by taking Siemens, Fowler, and Callender cables, and it was found that the average cost of low-pressure mains was £1,000, and for high-pressure £500, with the transformer at £3 to £4 per kilowatt. Next, as to maintenance of mains: for low-pressure, energy wasted (taking the same in both systems) was £36. 10s., interest (on £1,000), £50; depreciation, Mr. Crompton's lowest figure 2½ per cent., £25—total, £111. 10s.; high-pressure energy waste, £36. 10s; interest (on £500), £25; depreciation, taking the high figure of 15 per cent., £20—total, £96. 10s. That is, the high-tension mains could be put down for half and maintained for less. Added to this, the 40 per cent. loss came in the low-tension case at the time of highest load, and also the maximum capacity of generating plant must be nearly 40 per cent. larger in the case of low tension. "Truth," said Prof. Fleming, quoting Bacon, "emerges sooner from error than it does from confusion." Figures, not beliefs, he urges, must be the watchword of the future.

Efficiency of Transformers.—We have received from Messrs. Spon and Co. No. 102 of the *Journal* of the Institution of Electrical Engineers, price 2s. This number will be particularly interesting to electrical engineers and those occupied in the use of transformers, as containing a full and revised report of the very suggestive and instructive discussion of Prof. Fleming's paper on transformers. The outcome of the discussion is considerably to advance the feeling of satisfaction with the alternating-current system, the practical points being brought out particularly by Mr. Kapp and Mr. Raworth, as well as by Prof. Fleming in his reply. Said Mr. Kapp: "Those of us who have to do with central-station work, and have to decide whether they should use alternating current or continuous current in any particular case, have up to the present been working to a certain extent in the dark. We knew that transformers would have less efficiency at light loads, but there was no reliable information. It was generally assumed that transformers at $\frac{1}{20}$th output have a very poor efficiency, down to 40 per cent. or 50 per cent., and this assumption, of course, made against the system of distribution, of which lightly-loaded transformers are a necessary part. We now see that it is quite possible to have transformers at 75 per cent. efficiency at $\frac{1}{20}$th, and 85 per cent. at $\frac{1}{10}$th of their full load. Now, a transformer need never be worked below $\frac{1}{20}$th, and if sub-stations are used $\frac{1}{10}$th will be more likely, and this minimum will be raised as time goes on, as more houses and different classes of houses are put on the mains, and the different requirements overlap the efficiency will be raised. But even without waiting for the future, we see that 80 per cent. efficiency can be obtained at hours of lightest load, and a much higher efficiency at fair loads. In other words, when we are earning least we waste 20 per cent., but when we are earning most, at hours of heavy load, we get an efficiency of 96 per cent., wasting only 4 per cent.; so that taking the whole efficiency for 24 hours the transformer system has actually a higher distributing efficiency than the continuous-current system if the feeders consume 20 per cent. at the time of heavy load." Mr. Crompton stated that while the possible generation of a supply unit at the lamps on the direct system is 37 tenths of a pound of coal, and the best figure in practice is 64 tenths, yet the best figure in alternate-current practice was 160 tenths, leaving 123 tenths, or 12·3lb. per unit, wasted. Mr. Raworth, combating this comparison, said: "In the case of Newcastle-on-Tyne, where they have to supply a very large district with alternate currents, they get paid for a certain number of units; the coal, or a black substance resembling coal, used to produce this result amounts to 20lb. per unit. At Liverpool, where a very large district has the advantage of the low-tension system, and also the advantage of accumulators, they, too, use 20lb. of the black stuff, presumably coal, to produce one unit. There is no difficulty in comparing the result. It is a happy circumstance that in both places they use this slack, worth 6s. or 7s. a ton, and they both also use Lancashire boilers with automatic stokers; so we have low tension fairly pitted against high tension, with absolutely equal results." Mr. Albright objected that practically batteries are not used at Liverpool, still the comparison is certainly suggestive. Dr. Fleming, in his reply, which is not given in this number of the *Journal*, forced the conclusions against direct-current distribution still further home. The transformer system has now very formidable advocates, and Mr. Crompton's rejoinder, which will doubtless be forthcoming, will be awaited with much interest.

Telegraphing the Home Rule Debate. — On special occasions, says the *Daily News*, such as the introduction of the Home Rule Bill on Monday, the central telegraph office is a wonderful scene of industry and mechanism. Indeed, on occasions which are not special, it is curious and bewildering enough. In the provincial instrument-room—which, of course, is principally concerned with Press messages—they have ordinarily between 400 and 500 of the most rapid instruments yet invented. These are the Wheatstone fast-speed transmitters, which rush through by clockwork the long ribbons of paper that have been perforated by another machine. Several perforators are required to keep going one of these transmitters, and in anticipation of the rush upon the resources on the establishment to be counted on very shortly after the Prime Minister should begin his long-looked-for speech, nearly a hundred additional sets of apparatus were provided for puncturing the messages. Additional news wires had also been established in all directions, no less than five being worked to each of the principal towns. In addition to these, a number of towns not normally in direct communication with London were put "through," and the staff of operators was largely increased on the occasion. As most persons are aware, the House of Commons is in direct communication with the Central Telegraphs by pneumatic tubes. Mr. Gladstone had not got far on with his speech on Monday afternoon before the shorthand reports, transcribed into long hand for the provincial press, began to be handed in to the telegraph clerks at the House of Commons, and, indeed, long before this the office had been deluged by descriptive matter for the country papers. These Press messages were immediately tucked into "carriers" and deposited into the tube, through which they were sucked away by the engines in St. Martin's-le-Grand, a distance of two miles and a half, which they ordinarily traverse in from five to seven minutes. On arriving in the hall on the ground floor of the Central Telegraph building, they would be immediately blown up through another tube to the provincial floor and instantly distributed to the staff to be perforated and transmitted. In order to avoid any possible loss of time in this pneumatic despatch from the House of Commons, one of the tubes ordinarily shared with the West Strand office was given up solely to the House, so that an uninterrupted flow of carriers containing the news transcribed by the reporters could take place. There was thus throughout the evening an unbroken series of these little subterranean Mercurys flying eastward with tidings of Home Rule for Ireland. The pressure at the Central Telegraph Office, between 6 and 8 more particularly, was something extraordinary, and even up to 2 o'clock in the morning the amount of work going on was altogether exceptional. Such times as these are most anxious for those responsible, for they are liable to many provoking accidents. For instance, when all their arrangements had been completed and everything in apple-pie order, some workmen set about felling a tree in the neighbourhood of Potter's Bar, and managed to drop it right across the telegraph wires, bringing down no less than 20 of the most important telegraph lines communicating with the principal towns in the North of England and Scotland. This obstruction of Home Rule—occurring, by the way, in the neighbourhood of Hatfield—happily proved as futile as other forms of it are destined to prove ultimately. There was just time to repair the mischief. It has been computed that not less than a million words—say, five hundred of the *Daily News* leader columns—were telegraphed from the House of Commons on Monday afternoon and evening. This is certainly one of the greatest feats of the kind ever yet achieved.

London Institution.—On Monday a lecture was given by Mr. Shelford Bidwell at the London Institution on "Electricity and Heat." Two years ago he had lectured on the relation of electricity to optics, and the relation of electricity to heat had an exceedingly important practical bearing. Experiments were first shown to exhibit the difference in heating power of the same current on different metals, and the researches of Dr. Joule on the relation between heat and current mentioned. The increase of resistance of platinum when heated was shown by heating a coil of this wire in a gas flame while in series with a straight length through which a strong current is passing; the result being to dim the redness of the straight part. The recent researches of Prof. Dewar and Prof. Fleming on the extreme reduction of temperature showed that the electrical resistance of all metals was reduced by extreme cooling, but impure metals less than pure, so that this effect had been proposed as a test of purity. The resistance of selenium was a subject that had been greatly debated. A number of physicists, amongst whom was Prof. Grylls Adams, maintained that the resistance of selenium increased with the temperature, and another class, headed by Werner Siemens, held that it was diminished. His own experiments, carried from freezing to boiling point, conclusively showed that the resistance increases until about 20deg. C., and after that further rise in temperature diminished the resistance, until at boiling point it was very low indeed. The resistance was very much lower in light than in dark—the now well-known property of selenium. The resistance of carbon is diminished by heat, and that of sulphur is also diminished; but a mixture of the two, curiously enough, gives an enormous increase of resistance on heating, the resistance increasing sixfold from 45deg. C. to 55deg. C. This might be explained by considering the mixture was formed of little crystals of sulphur, with carbon crystals in between, allowing a certain number of complete chains of carbon particles. Both expand on heating, but the sulphur nearly ten times as much as the carbon; the particles are drawn apart and the number of complete chains of carbon is diminished. The experiment was shown by means of a plate of insulating material wound over with two parallel coils of platinum wire acting as electrodes, the sulphur-carbon mixture being smeared over the wires. (As a relay alarm indicator, perhaps this device of Mr. Bidwell's might be useful instead of a fuse on important installations—the action being almost instantaneous.) The thermo-electric currents were then discussed. Lord Kelvin some years ago pointed out that there were four E.M.F.'s to be considered on a thermo-electric junction, due to difference of potential of the two junctions and also in the same metal differently heated. Experiments were shown to demonstrate that the movement of the heated part, as by moving a flame along a wire, generated a current, and the earth's magnetism had been thus explained as being due to the rotation of the sun's heating effect—an ingenious theory not, perhaps, exact. The E.M.F. of heated and unheated junction caused the text-book arrangement of thermo-electric series to be not absolutely accurate. The great problem of the future is the conversion of heat direct into electricity. In 1lb. of coal is stored mechanical energy equal to 6 h.p. for one hour; in obtaining the power by steam-engines we have to pay a commission for conversion of 92 per cent.—a ruinous exchange; nor is there any prospect of great improvement, for the steam-engine must remain very wasteful. The loss in the dynamo is often less than 10 per cent., and in comparison with that of the engine is negligible. If the steam-engine and dynamo could be done away with, instead of six lamps per pound of coal per hour we might light 72 lamps. But, further, even then there is the problem of obtaining light without heat, the light of the glow-worm. This can be done on a small scale in the Geissler tubes, and attempts, by Tesla and others, are directed to the perfection of this phosphorescent light. Then, instead of huge engines wastefully producing heat vibrations, as in the present central stations, it is hardly too much to say, in the words of Dr. Lodge, that "a boy turning a handle might produce as much light as is produced by all this mass of material." Both scientific and practical men were bent on obtaining this result, though as yet with hardly more than the promise of success.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 154.)

In working out problems on the magnetic circuit, the first thing to know how to calculate is the magneto-motive force of a coil. A unit line of force is of such intensity that it would act with the force of one dyne upon a unit pole positioned in its path. Unit intensity of magnetic field exists when there is one line of force per square centimetre. Magneto-motive force, or magnetising force, is denoted by H, and when the medium through which the magnetic lines flow is of air, the intensity of the field is measured by H also, because the permeability of air is 1—that is to say, if the magneto-motive force be 15, then 15 lines of force per square centimetre will flow when air is the medium. H is dependent on two things: (1) The strength of the current, (2) the number of turns of wire. The product of the above is named the ampere-turns.

When merely the intensity of H is required, the value of H must be divided by the length of the circuit in centimetres; but for calculating the magnetic flux in a circuit, the total magneto-motive force is required, and so length is left out. For the future, H will signify this total magneto-motive force. The product ampere-turns can be made up of any two factors so long as the product remains constant; for example, suppose the current were nine amperes, and that it circulated round the iron 100 times, then the ampere-turns would be 9 × 100 = 900. If the current were one ampere, and it circulated 900 times round, the ampere-turns would still be 900, and the magneto-motive force would be the same as before.

It was stated that unity intensity of field existed when there was one line of force per square centimetre. A unit magnetic pole signifies a centre of magnetism, such that all round it on every side there is a unit intensity of field at a distance of one centimetre from the centre. This enclosing space is evidently of a spherical form, the pole being in its centre, and as the radius or distance between the centre and the boundary surface is one centimetre, the surface of the sphere will have 4π square centimetres; and since there is unity intensity of field at every point on the surface, therefore there will be one line of force per square centimetre, and as there are 4π square centimetres, consequently there must be 4π lines of force issuing from the pole, or magnetic centre.

The above theoretical digression is necessary in order to explain the complete formula for magneto-motive force. Other things being measured in absolute or C.G.S. units, the current must be expressed in absolute units, and that being so, the magnetising effect of one absolute unit of current circulating once round will produce 4π lines of force. Now, an ampere is one-tenth of the absolute unit of current, therefore one ampere-turn $= 4\pi \div 10 = 1{\cdot}256$ lines, so that

$$\text{Magneto-motive force} = \text{ampere-turns} \times 1{\cdot}256.$$

$$\text{or,} \qquad H = 1{\cdot}256\,S\,i,$$

where H = total magneto-motive force,
,, S = number of turns of wire,
,, i = current in amperes.

For example, suppose a bar of iron to be wound with 1,000 turns of wire through which a current of 20 amperes was sent, then the total magneto-motive force would be

$$H = 1{\cdot}256 \times 1{,}000 \times 20 = 25{,}120.$$

The magnetic resistance of the circuit depends on its dimensions and on the value of μ. The former is like the electric circuit, proportional to length and inversely proportional to area. The value of μ depends on the value of B, or density of lines per square centimetre that are likely to flow through the iron; so that when B is found, μ is found by referring to tabulation 17 or 18. We have thus the following formula:

$$R = \frac{l}{\mu a},$$

where R = total resistance,
,, l = length in centimetres,
,, a = cross-sectional area in square centimetres,
,, μ = permeability.

Where the circuit is composed partly of air and partly of iron, the several portions must be added together for the total resistance.

The magnetic circuit of a dynamo may be divided up into three portions: 1. The field magnets. 2. The two air-gaps. 3. The armature core. Here the law would be

$$\text{Magnetic flux} = \frac{\text{Magneto-motive force}}{\text{The three magnetic resistances}}.$$

$$\text{or,} \qquad N = \frac{1{\cdot}256\,S\,i}{\dfrac{l_1}{\mu_1 a_1} + \dfrac{2\,l_2}{\mu_2 a_2} + \dfrac{l_3}{\mu_3 a_3}}.$$

In the electric circuit the current is the same at any point, so in the magnetic circuit the magnetic flux is the same at any point. In the former, the difference of potential between two points is obtained by multiplying the current by the resistance between those two points; in the latter, the difference of magnetic potential between two points is obtained by multiplying the magnetic flux by the magnetic resistance between those two points.

Since the permeability of air is unity, therefore when the magnetising or magneto-motive force has a value of one C.G.S. unit, there will be a magnetic induction, B, of one line of force per square centimetre, so that for air H signifies both the magneto-motive force and the magnetic induction, B; or H = B.

The following example will show how to calculate the number of ampere-turns required to give a certain magnetic flux in a circuit of given dimensions. A dynamo requires a magnetic field having a total flux of 2,000,000 lines of force, how many ampere-turns must be wound on the magnet limbs? The dimensions of the circuit being as follows, leakage being neglected:

	Length.	Area.
Field magnets ...	100cm.	400 sq. cm.
Air-gap	1·5 ,,	800 ,,
Armature core ...	20 ,,	200 ,,

The induction, B, per square centimetre through the field magnets comes to 5,000 lines, and signifies a permeability of 2,500. The induction, B, per square centimetre through the armature core comes to 10,000 lines, and its permeability is hence 2,000. The induction, B, per square centimetre through the air-gap comes to 2,500 lines. The value of μ for air being 1.

$$\text{Ampere-turns} = \frac{\text{magnetic flux}}{1{\cdot}256}\left(\begin{matrix}\text{The sum of the three}\\ \text{magnetic resistances}\end{matrix}\right)$$

$$\text{or,} \qquad S\,i = N\left(\frac{l_1}{\mu_1 a_1} + \frac{l_2}{\mu_2 a_2} + \frac{l_3}{\mu_3 a_3}\right) \div 1{\cdot}256.$$

The first resistance term being that of the field magnets, the second that of the two air-gaps, and the third that of the armature core. Inserting values, we have

$$Si = 2{,}000{,}000\left(\frac{100}{2{,}500 \times 400} + \frac{2 \times 1{\cdot}5}{1 \times 800} + \frac{20}{2{,}000 \times 200}\right) \div 1{\cdot}256$$

$$= 2{,}000{,}000\,({\cdot}0001 + {\cdot}00375 + {\cdot}00005) \div 1{\cdot}256\,;$$

$$= 2{,}000{,}000 \times {\cdot}0031 = 6{,}200.$$

So that 6,200 ampere-turns would be required.

Generation of Currents.— All dynamo-electric machines consist, broadly, of two parts. The first part may be called the "magnetic circuit," and the second part may be called the "electrical circuit." The first comprises the two magnet limbs, the yoke, and the pole-pieces, called collectively the field magnets; to this must be added the iron core of the armature. The second comprises the armature wires, the brushes, and the conducting wires, lamps, etc. We have thus to deal with two separate and distinct circuits—one being magnetic, the other being electric. To produce a current of electricity in the closed electrical circuit, part of this circuit must be put into motion, so as to cut through part of the magnet circuit; this moving part of the electric circuit is named the "armature," and the part of the magnetic circuit which it cuts through is evidently the magnetic field existing in the air-space between the two poles of the field magnets. It does not signify which circuit moves, or which is stationary, but one of the two must move. Some dynamos are built in which the field magnets move round whilst the armature remains stationary, but it is more the custom to rotate the armature, and this custom will be followed.

Since the armature part of the circuit rotates, sliding connections, called "brushes," join it to the rest of the circuit, consisting of the conducting mains, switches, lamps, etc. The iron core of the armature serves two purposes—it firstly, and chiefly, assists to fill up the air-gap inside of the armature ring or drum upon which the wires are wound, and so provides a path for the magnetic lines; secondly, it acts as a mechanical structure necessary for the proper strength of the machine; so that, although rotating with the armature, it forms part of the magnetic circuit.

An armature is built up with a great number of wires, which are wound round an iron core keyed on to the machine, the shaft being driven either by belting or else direct by being coupled up to the steam-engine shaft. A brief explanation as to the way various kinds of electric currents are generated in the armature will now be given.

Electric currents produced by dynamo-electric machinery may be classed under four distinct heads as follows: (*a*) Alternating currents; (*b*) polyphase currents; (*c*) pulsating currents; (*d*) continuous currents.

Every dynamo, by virtue of the rotation of a conductor in a magnetic field, gives, in the first place, an alternating current, and the other kinds are simply modifications of it, as will be noticed later on. The currents used at present for distributing light and power are either alternating or continuous with regard to polyphase currents. This system being new, and mostly confined to experimental plants, it will be described separately, together with dynamos and motors working by these currents. Concerning pulsating currents, this kind is at present very limited in its application, and within the last year or two has been found useful in working reciprocating electric machines, such as percussion rock drills, etc.; this subject will also be discussed in due season.

WHAT IS ELECTRICITY?—III.

BY SYDNEY F. WALKER.

Generation: (a) By Friction.— Of all portions of this difficult subject, probably the problem of generation presents the greatest difficulty. We rub a glass rod with a silk cloth, and straightway the rod and the cloth have acquired certain properties which we have agreed to call electrical. What is the cause of this, and what is the new state which we have set up in these bodies? In the writer's opinion the energy which we have expended in rubbing the rod has been converted, nearly all of it, into the three different forms of motion represented by heat, sound, and, as he believes, electricity. We can find similar physical conversions among things we are familar with, in many cases conversions into heat and sound, without, as far as we know, evidence of the generation of electricity; in a few cases we have distinct evidence of the creation of all three, and sometimes even of light as well.

Consider the case of a heavy weight, such as a mass of rock, falling from a height, or a heavy rifled shot striking the armoured side of a modern battleship. In either case we know that the weight, at the moment it reaches the ground, or the object, is the receptacle of a certain amount of energy. It is the carrier of a large amount of energy. Immediately the blow has fallen, apparently a large portion of this stored energy has disappeared. The rock, perhaps, will have driven itself bodily into the ground where it strikes, crushing anything it falls on. The shot will have made a dent, perhaps a crack, in the armour-plate it strikes. But do these represent the whole energy stored in the rock and in the shot? Certainly not. Where, then, is the rest? Evidently it is converted into molecular vibrations of the falling bodies themselves, and of the bodies they strike. We know that we have sound and heat produced on these occasions, and it is more than probable that we have electricity also.

Take, again, the case of a steel shaft turning in a brass bearing which is either too small, out of truth, or not properly oiled. We find that we lose a large portion of the power which we deliver to the shaft, if any of these things are present, after passing this bearing—that is to say, we cannot obtain from the shaft the power we deliver to it by a very large margin. Where does this energy go? It cannot be lost. We know that the energy which is thus wasted for our purpose is transformed into sound and heat, sometimes also into light, and we have good reason to suppose that a portion is converted into electricity.

Take, again, the case of a leather belt driving a pulley. Here we have all three—heat, sound, and electricity—generated at the same time; and we have distinct evidence of the latter in favourable cases, such as in some portions of flour mills, because we can take sparks, which we know can only be given off by electricity, from the pulley.

It appears to the writer then, that whenever friction takes place between any two bodies, or any two substances, the energy which we look upon as wasted becomes molecular vibratory energy, but not in any one form. Part of the energy would appear to give motion between the rates we know as sound, part between the rates and form we know as heat, and occasionally even the higher rates we know as light, and the remainder, the writer contends, at a rate between the two, which produces the phenomena we know as electrical. The fact that we can have all these forms of energy present at the same time in the same body or group of bodies is well known. Take a copper wire, for instance, and pass an electric current through it. As soon as the current passing is of sufficient strength, not only heat but light are present, and, as we know well, we can easily generate sound from a portion of the energy present, say by letting a drop of water fall on the glowing wire.

But the question at once arises, how do these motions go on together? We know that they are produced by independent increments of energy, but how can they exist at the same time in the same body? Does the same molecule vibrate at a high rate with heat energy and at a low rate with acoustic energy at the same moment. This, perhaps, is another of the difficult problems that will have to be followed out. The writer's view is that different molecules, or groups of molecules, accept different rates of vibration, according to the conditions present. Those, for instance, that are most free take the largest rate of motion, and give rise to sound. Those in which the other conditions are such as to resist or confine the motion, take it up as motion at a higher rate, but with a small amplitude and a different direction of motion. One can see something analogous to this going on in every engineering works, even so as to be visible to the eye. Place a bar of steel in the lathe and proceed to take a cut from it with a steel turning tool. Watch the cuttings as they come from the lathe, particularly if they are small. Some of them spring out several inches from the bar. Nearly all, however, fall down on to the turning tool itself. Watch them further, and you will notice that in the small space at the end of the tool covered by these small turnings there are samples of different rates and different forms of motion. As each cutting comes from the bar it pushes against one or more of those previously on the tool, and soon another pushes against it, and all the time the tool itself is in motion both within itself and as a whole, and the result is that these forces, being free to act on the loose aggregation of turnings, produces each its full effect, with the result seen. How is it, too, that a few of the turnings spring out from the bar instead of falling on the tool? This, again, is due to the resultant of the forces acting on each particular turning. It should be remembered, too, that close bodies, such as glass, do not produce either sound, heat, or electricity with facility. Everyone knows the trouble one has to take with a glass rod to produce either by friction, but it produces sound with least facility and heat with greatest. Metals, on the other hand, convert mechanical energy into all three with ease.

ELECTRICAL RAILWAYS.*

BY DR. EDWARD HOPKINSON, M.A., M.I.C.E.

After reference to the recent progress made in the United Kingdom in the application of electric traction to tramways, and a comparison of this with the work done on the Continent and in the United States, a brief account was given of the conditions which Messrs. Mather and Platt, of Manchester, were required to meet in their contract for the electrical plant of the City and South London Railway. The leading features of the line were briefly alluded to. The maximum gradients were 1 in 14 with, and 1 in 30 against, the traffic. There were four intermediate stations between the City terminus and that at Stockwell, the trains running at intervals of from three to four minutes. The total length was 3 miles and 270 yards. Full details were given of the generator station. There were eight boilers of Lancashire type set on the Livet principle, with Vicars automatic stokers, working at 140lb. pressure per square inch. The generating plant consisted of four open vertical compound engines, and four "Edison-Hopkinson" dynamos. The latter were belt-driven, and had an electrical efficiency at full load of 96 per cent., and a commercial efficiency of 93·4 per cent., their weight being 17 tons. They were compound wound, and had a maximum output of 450 amperes at 500 volts, running at about 500 revolutions per minute. In connection with the driving of the generating dynamos, the theory of jockey pulleys on high-speed belts was incidentally considered.

The feeding conductors employed were of the Fowler-Waring type, the working conductor being of channel steel, laid between the rails and carried on glass insulators fixed to the sleepers. The channel, rolled from a special quality of steel, had a specific resistance as low as 0·0000105 ohm at 24deg. centigrade. The actual leakage on the entire system, including generating dynamos, feeders and working conductors, was in general 0·5 ampere, corresponding with a loss of 0·3 h.p. The return circuit was through the rails, which were uninsulated, and the method of dealing with the conductor at points and crossings was described.

The use of the uninsulated rails as the "return" was discussed, as well as the effect of the earth currents thereby generated. Observations at the Royal Observatory, Greenwich, as also those made by Profs. Ayrton and Rücker, showed that, in addition to the earth currents, there were magnetic effects perceptible at considerable distances from the line. These disturbances were, however, small, and of no practical importance in connection with the working of telegraph and telephone systems in the vicinity.

The essential and novel feature in the design of the locomotives was that the armatures of the motors were built directly upon the axles, whilst the magnets were supported partly on the axles, and partly on the frames; thus, gear of any description was entirely obviated, and the mechanism was reduced to its simplest elements. It was shown that the system of direct-driving did not require a greater dead weight upon the line than was usual in ordinary locomotive practice, and that no injurious effects upon the armatures could be traced to vibration. The total weight of each locomotive was 10 tons 7cwt., the length over the buffers being 14ft., and the wheel-base 6ft.

The two motors on each locomotive on the City and South London line were both capable of developing 50 h.p., corresponding with 310 revolutions of the axle per minute. The magnets were of the "Edison-Hopkinson" form, series wound, the armatures being of the Gramme ring type. The tractive force of the locomotives, with a current of 100 amps., was 1,180lb., and the maximum tractive force 3,000lb.

The trains were fitted with the Westinghouse continuous automatic brake. Instead of a pump working continuously on the locomotive, the latter was provided with reservoirs placed under the curved side-plates of the cab, and charged with air at a pressure of 80lb. at the end of each journey. The reservoirs were of sufficient capacity to provide for about 30 stops from full speed.

The efficiency of an electric railway system might be considered under three heads: (1) The production of electrical power; (2) its distribution; (3) the reconversion of electrical power into mechanical power.

With regard to the first head, it was shown that the daily consumption of electrical energy, with eight trains in constant work, was about 3,700 units, which were produced by the combustion of 7·5lb. of Welsh coal per unit. As in the case of electric-lighting stations, the efficiency of production of electrical power was greatly reduced owing to the variations of load. The average load on the generating engines and dynamos was only about one-half their full load, and consequently they could not work under conditions of maximum efficiency.

The distribution of electrical power was shown to be strictly in accordance with Lord Kelvin's well-known principle—that the cost of power absorbed in the conductors should be equal to the charge for interest on the capital invested in them. Thus the cost of distribution was a minimum. The average loss in the conductors was about 10 per cent. The average efficiency of the locomotives, under the actual conditions of running, was shown to be 70 per cent., and the electric efficiency of the entire system was 62 per cent. These results substantiated the estimates of efficiency given in evidence before the Parliamentary Committees on the Central London Railway Bill by Sir Benjamin Baker and Dr. John Hopkinson.

The cost of working the railway in successive half-years was deduced from the company's half-yearly returns; and it was shown that the present cost of running, including all expenses of working and maintaining the generating station and locomotives, was 6·3d. per train mile—or 20 per cent. less than the cost guaranteed by Messrs. Mather and Platt. The cost of repairs of the generating plant and locomotives was only 0·39d. per train mile. The trains, when normally loaded, weighed 40 tons, and accommodated 100 passengers. Their average speed, including intermediate stoppages was 11·5 miles per hour, and that of actual running between stations 13·5 miles per hour. The maximum speed attained between stations varied from 20 to 25 miles per hour. The train mileage for the half-year ending December 31, 1892, was 214,417. Since the opening of the line two years ago, the locomotives had run more than 820,000 miles, and had dealt with a traffic of over 12,000,000 passengers.

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* Paper read before the Institution of Civil Engineers.

INTERNATIONAL ELECTRICAL CONGRESS AT CHICAGO.

The Sub-Committee on Provisional Programme have drawn up a report for the American Institute of Electrical Engineers to suggest what work it is desirable to have done at the International Electrical Congress at Chicago this year.

The committee recommends as follows:

1. *Ratifications.*—As an act of courtesy, it is proposed to ratify the adoption of units, terms, symbols, and definitions by previous International Electrical Congresses. (This was done at Paris and Frankfort Congresses.)

2. *New Units.*—Defining and adopting practical units for measuring and designating: magneto-motive force; magnetic flux; magnetic intensity; magnetic reluctance; electric conductivity; illumination. This refers only to the magnitude of the units—what multiples or sub-multiples of the absolute units they are to be. Past experience has shown that the proper time to establish units is before their need is universally felt, to avoid the introduction of units of different values.

The committee recommend the following:

The value of the practical unit of magneto-motive force to be one-tenth of the absolute unit—that is, equal to $\frac{1}{4\pi}$ ampere-turn.

The value of the practical unit of magnetic flux to be 10^8 absolute units or lines.

The value of the practical unit of magnetic intensity to be 10^8 absolute units—that is, 10^8 lines per square centimetre.

The value of the practical unit of reluctance to be 10^{-9} absolute units.

The value of the practical unit of electrical conductivity to be 10^{-9} absolute units—that is, to the reciprocal of the ohm. This makes it equal to the unit proposed some time ago, and known to some extent by the name of "mho." It should be given this value in order that it correspond with the already adopted units.

The value of the practical unit of illumination to be a bougie-decimale at the distance of one metre. The bougie-decimale is the unit of light or candle-power already established, and is practically equal to one English standard candle; by making the distance a metre, the practical unit will be approximately equal to one-tenth of a carcel-metre, one-tenth of a foot-candle (or "lux"), or to one metre-candle or metre-kerze, all three of which units are already in use to some extent.

It is urgently recommended that changes in the values of pra tical units, as the ampere and farad, should not be favoured, since they would necessarily be followed by great confusion.

3. *Names for New Units.*—The following names are suggested for the above units :

For the practical unit of magneto-motive force, the name "gilbert."

For the practical unit for magnetic flux, the name "weber." This term was formerly applied to a unit of current, but its use in this sense was so limited, and it has been abandoned for so long a time that no confusion would be likely to arise ; the context alone would always be sufficient to prevent any possibility of misunderstanding. The name "weber" is preferred on account of the intimate relation between this unit and that of magnetic intensity, for which the name "gauss" is suggested.

For the practical unit of magnetic intensity, the name "gauss." This name has already come into use to such an extent that objections to it will not be likely to arise.

For the practical unit of magnetic reluctance, the name "oersted."

For the practical unit of inductance, the name "henry." This name has already come into use extensively, and it would therefore be very undesirable to change it. The value of this unit has already been fixed as equal to 10^9 absolute units or nearly to the length of an earth's quadrant. The definition "quadrant" is sometimes employed as the name itself, but its use as a name is evidently objectionable, as it already has several other meanings, which might readily lead to confusion.

For the practical unit of electrical conductivity, equal to the reciprocal of the ohm, the name "mho." This name has been in use for some time, and is already well known. It is thought better to recommend it than to select and introduce a new name.

For the practical unit of illumination defined above, the name "bougie-metre."

It has been suggested to name the units "kilowatt-hour" and "ampere-hour." The committee, however, recommends that inasmuch as these terms explain themselves, and are not longer than some others in use, to give them special names would burden a system of nomenclature unnecessarily. The principal objections to the term "Board of Trade unit," which is in use in England for the former, are, that it could never become international, that it is longer by one syllable than the term "kilowatt-hour," and that there are now, or may soon be, units of other denominations adopted by the same Board of Trade, from which this one will have to be distinguished by an additional affix or prefix.

4. *Concrete Standards.* — Defining and adopting modes of embodying the following principal units of measurement in concrete standards capable of being readily reproduced, and adopting names for them or for the theoretical units, by which they can be distinguished from each other : Ampere, ohm, volt, watt, standard candle. The following definitions of these units are recommended :

An ampere shall be that unvarying current, which, when passed through a solution of nitrate of silver in water, in accordance with the specifications recommended in the recent report to the British Board of Trade, deposits silver at the rate of 0·001118 of a gramme per second.

An ohm shall be the resistance offered by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area, and of a length of 106·3 centimetres. It is recommended that material standards of this value, constructed in solid metal, should be preserved under the care of the several Governments, as standards of comparison, and that they should from time to time be verified by comparison with the mercury standard defined above ; also, that for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed which should be periodically compared with the standard ohm.

A volt shall be the product of this ampere and this ohm.

A watt shall be the product of the square of this ampere and this ohm.

The other units, such as the coulomb, the farad, and the joule, shall be taken as derivatives in terms of this ampere and this ohm.

In order to create as little confusion as possible by the introduction of this set of units, which are to become the universal standards, and in order to distinguish them readily from the true theoretical, or abstract units defined in terms of the absolute units, it is recommended to call the former simply "amperes," "ohms," "volts," etc., or more specifically "standard amperes," "standard ohms," etc., and to call the theoretical units "true amperes," "true ohms," etc. The latter term has already come into use in this sense.

The unit of resistance known as the B.A. unit, shall be taken as equal to 0·9866 of this ohm.

The E.M.F. of a Clark cell at 15deg. C., prepared in accordance with the specification recommended in the recent report to the British Board of Trade, shall be taken as not different from 1·434 of these volts by more than one part in one thousand. The coefficient of temperature shall be taken as ———

The standard candle shall be taken as equal to the light from a lamp like that known as the Hefner-Alteneck standard amyl acetate lamp, which is to be defined by its dimensions and the height of the flame, the dimensions being such that the light shall be equal to that of the "bougie-decimale," the practical unit adopted at the Paris Congress of 1889, which is equal to one-twentieth of the absolute platinum standard adopted in 1884.

Wire Gauge.—The committee recommends that no action be taken with reference to a universal wire gauge. The universal introduction of the metric system and the designation of wires by their diameters in millimetres, is thought to be the only satisfactory solution of this question for international work.

5. *Notations and Symbols.*—Adopting an international system of notation and conventional symbols for designating different quantities.

The system suggested to the last congress by Mr. E. Hospitalier, of Paris, is recommended, although doubtless some amendments may be found desirable.

6. *Definitions.*—Defining the following terms: Impressed E.M.F., inductivity, inductance, reluctivity, Matthiessen's standard, north and south pole. The following definitions are suggested :

The impressed E.M.F. is the ratio of the total activity in an electrically conducting circuit to its instantaneous current strength.

The inductivity at any point in an isotropic medium is the ratio, added to unity, of 4 π times the intensity of magnetisation there existing to the magnetising flux-density. Inductivity is synonymous with "permeability." The electromagnetic dimensional formula is $L^0 M^0 T^0$; the conventional symbol is μ.

Inductance.—(*a*) Self-inductance is the ratio of the total magnetic induction linked with and established by an electric current to the uniform strength of the same. The inductance of a conducting circuit is constant when its environing medium has constant inductivity. (*b*) The mutual inductance of one electric circuit upon another is the ratio of the total magnetic induction linked with the second, due to a uniform current in the first, to the strength of that current. The mutual inductance between two electric circuits is reciprocally equal when the environing medium has constant inductivity. The electromagnetic dimensional formula is $L^1 M^0 T^0$. The absolute unit is one centimetre ; the practical unit, one henry.

The reluctivity of a medium at any point is the volume differential of the reluctance thereat. Simple definition : Reluctivity is the reluctance per unit volume. The electromagnetic dimensional formula is $L^0 M^0 T^0$. The absolute unit is one C.G.S. unit of reluctance per cubic centimetre ; the proposed practical unit is the same or about one oersted per cubic earth quadrant.

The resistance of copper known as Matthiessen's standard shall be defined as follows : The resistance of a soft copper wire one metre long, weighing one gramme, is 0·14365 B.A. units at 0deg. C. This definition is recommended by the committee of the American Institute of Electrical Engineers on Matthiessen's standard. The reasons for selecting it are given in that report.

The north pole of a magnet to be defined as being that which seeks the geographic north pole, and the south pole that which seeks the geographic south pole. This is the generally accepted definition, but it is thought desirable to formally define it.

7. *Expressions.*—Defining and adopting expressions : For alternating currents of more than one phase ; for describing phenomena of alternating currents and of electromagnetic waves.

It is recommended to adopt the following expressions : "simple" alternating current for the usual alternating currents in which there is practically but a single phase ; "diphase" alternating currents for two alternating currents whose phases differ in time by 90deg. or 270deg. ; "triphase" alternating currents for three alternating currents whose phases differ in time by 60deg. or 120deg.; "polyphase" alternating currents for such as have more than three phases.

For expressions describing phenomena of alternating currents and electromagnetic waves, the committee solicits suggestions.

8. *Universal Use.*—Recommending the more universal use :

Of the term "voltage" as synonymous with "difference of electrical potential" or P.D. in place of the terms "potential," "tension," or "pressure," the use of which in this sense it is recommended to abandon.

Of the term "transformer" instead of "converter ;"

Of the term "dynamotor" for a continuous-current transformer;

Of the term "continuous current" instead of "direct current ;"

Of the term "kilowatt" instead of "horse-power ;"

Of the metric system of weights and measures, and suggesting means by which its introduction will be facilitated.

Discussion.—In order to carry out the above programme, the committee recommend that discussions be at once opened on the above subjects, in order that agreement and settlement, not discussion, may be made at the congress. They request that reports of such discussions be sent to the General Congress Committee at 12, West Thirty-first-street, New York, and that a sub-committee prepare a classified summary thereof. The discussion should close by July 1, 1893.

It is suggested that scientific societies should co-operate by appointing special committees to report, and that their report be published in the technical journals of their country. The committee believe that to postpone discussion until the congress is in session would lead to no satisfactory result, and urges that discussion take place in the journals prior to the congress, and the only report submitted be a summary of such discussions.

Meetings.—Regarding the meetings of the congress, your committee recommends that, as in the Paris Congress of 1889, the meeting be divided into (*a*) general meetings, one at the opening and one at the closing of the congress, which are to be devoted to the consideration of general questions and those on which agreements are desired, and to the reading of papers of a general character ; (*b*) sectional meetings for the reading of all other papers. The following division into sections is recommended : 1. Electrophysics, units, measurements, and all electrical matters of a purely scientific nature. 2. Dynamos, motors, transformers, etc. 3. Systems, central stations, installations, lamps, etc. 4. Electric telegraphy, telephony, and signalling. 5. Electric railways. 6. Electro-chemistry, batteries, electro-metallurgy. 7. Electro-physiology and electro-therapeutics. 8. Legal questions.

Papers.—It is suggested that specific invitations be extended by the Congress Auxiliary to prominent electrical engineers and physicists to prepare papers on specified subjects to be read and discussed at the congress meetings. Also that a general invitation be extended for other papers, which are to be submitted not later than July 15, 1893, to a Committee on Papers appointed by the chairman of the Congress Auxiliary; that this committee shall examine and accept or return the latter, and at its discretion shall print any or all of those accepted, as well as those solicited, in form for circulation at least one week prior to the meeting at which they are to be read; that the papers shall be read in full, in abstract, or by title, as that committee shall direct.

The following subjects of papers are offered as a suggestion to the Congress Auxiliary merely as a basis and not as a complete list: The criterion of sensitiveness of galvanometers, or on the theory of their construction. The working of national or municipal laboratories for testing meters and instruments. The practical results and economy of the employment of accumulators in central-station systems of supply. On the relation between weight of copper and iron in dynamos and their output. Nomenclature and notation of magnetic circuit—or on standard and units of magnetism. Magnetism. On the economic use of transformers under various conditions of supply. Electricity meters from an European standpoint. Electricity meters from a British standpoint. Electricity meters from an American standpoint. Choice of materials for standard of electrical resistance. Nomenclature of phenomena of electromagnetic waves. Standards for electrical measurement. Alternating-current transformers from an American standpoint. High-frequency and high-potential phenomena. Dynamo construction.

The committee suggests that papers should be solicited by the General Congress Committee of this institute on the work of the early electricians of this and foreign countries considered from a modern standpoint, and their importance in the development of the science of electricity, including descriptions and illustrations of models and apparatus used.

Transactions.—The committee recommend that a shorthand report be made and printed of the proceedings and discussions at the Electrical Congress, to be supplied on payment of 1dol. to members and 5dol. to non-members.

Membership.—It is suggested that there should be "delegated members" and "members"; dues from each, 5dol.; that only delegated members and members be admitted to meetings or permitted to take part in discussions; that anyone shall be entitled to become a member; that delegated members shall be appointed by Governments, physical and electrical societies, and shall be approved by an international committee whose decision shall be final; that questions on which international agreement is desired be decided by the delegated members, whose decisions shall be submitted to the whole congress for approval or rejection in part or in whole, but not for alteration.

It is recommended that the United States Government be requested to extend a formal invitation to foreign Governments and societies to send delegates to this congress.

The committee has embodied in this report recommendations from the reports of the institute's committee on Matthiessen's standard and on magnetic units, from the recent reports of the British Board of Trade Committee, and from the suggestions of Dr. Silvanus P. Thompson to Dr. Elisha Gray, in reference to the congress. The report is signed by Carl Hering (chairman), Wm. A. Anthony, and A. E. Kennelly.

LEGAL INTELLIGENCE.

TIBBITS v. ALABASTER AND OTHERS.

In the Queen's Bench Division on Wednesday, before Mr. Justice Mathew and a special jury, Dr. Herbert Tibbits, of Regent's Park, and founder of the West-end School of Massage and Electricity, sued the proprietors and publishers of the *Electrical Review* to recover damages for an alleged libel. Defendants justified the words complained of, and pleaded that they were fair comment on a matter of public interest.

Sir R. Webster, Q.C., Mr. Wallace, and Mr. Germaine appeared for the plaintiff; while Mr. Lawson Walton, Q.C., and Mr. Bankes represented the defendants.

Sir R. Webster, in opening his case, stated that Dr. Tibbits had taken a Scotch degree, and that the case referred to the apparatus in use by the Zander Institute in Oxford-street, which institute had had large sums of money spent upon it, and, so far as regards this case, it did not matter whether this apparatus was of the nature of quackery or not. Ever since the institute had been opened repeated invitations had been made to medical men and others to visit the place and examine the apparatus, and he thought, if it was of the nature of quackery, that such invitations would not be so freely given. Reference was made to Mr. Harness as the patentee of a number of electrical appliances, one of which was the electropathic belt, which was shown and explained. The inventor and others thought that mild currents of electricity passed through the body were beneficial, and that by using these belts such a mild current was passed through the body. Electricians would probably say in their evidence for the defence that the currents generated were so small and of so little power that they would do no good, and that the current was not passed through the body. The plaintiff would go into the box and would state that he had paid particular attention to massage and other methods of treatment of ailments for a number of years, and that at first he did not believe in the efficacy of these belts. He had, however, been invited to report upon these belts as a professional man in the usual manner, for which he received a fee and had given a lengthy report, in which he explained in detail the experiments that he had made and the results obtained. The report was sent in in the usual way, and was published in its entirety, and he believed that as a whole it was the honest opinion of a competent medical man. Sir Richard Webster then read the whole of the article contained in our contemporary of September 23rd, pointing out specially the passages which were relied upon as being libellous, and stating that they were calculated to do almost as much harm as possible to a medical man, and this was particularly the case with regard to Dr. Tibbits, in that he was a bankrupt. If necessary, he had gentlemen and ladies to witness to the benefit they had obtained from wearing these belts, and he thought his client was entitled to substantial damages.

In the examination-in-chief of **Dr. Tibbits**, it was stated that the plaintiff was a Doctor of Medicine of St. Andrew's University in Scotland, and had been 28 years in practice. There was one point in relation to this case which, he thought, it might be as well to refer to—viz., that the plaintiff was an undischarged bankrupt, and he explained that the bankruptcy had been brought about because the plaintiff had guaranteed the expenses of certain bazaars. The result proving a great loss he had been brought to the bankruptcy court. The plaintiff had paid special attention to massage and treatment of ailments by electricity. He had written several books upon the subject, some of which had gone through several editions, and from long experience he placed a high value upon electricity in cases of paralysis, pain, spasms, and debility. He had been requested by Mr. Harness to examine and report upon the electropathic belts, otherwise he had nothing to do with the Medical Battery Company or the Zander Institute. He was asked to report in the ordinary course of his practice, for which report he asked and obtained 100 guineas, but before consenting to report he took two or three days to consider, and on accepting stated that whether the report was favourable or unfavourable it was to be accepted. His examination of the apparatus submitted to him lasted some six weeks or two months. He had made a careful investigation and a truthful and honest report, suppressing nothing, and having submitted the report he had no voice in the subsequent publication. In his report he stated that he had ascertained that a current passed through the body when the belt is worn and the opposite poles were metallically connected. As a medical man he was of opinion that a mild current of electricity passing through the body for long periods would have a beneficial effect, and that was the result, not only of the experiments with the electropathic belts, but of his previous experience. During the time that he had the belts under investigation he had inspected the premises of the Medical Battery Company and the Zander Institute, and had examined the electrical apparatus which was to be found there, and which he considered was the best he had ever seen. The apparatus consisted of the very best class of apparatus which had been used for the application of electricity for many years. Referring to the Bloomsbury trial, mentioned in the article complained of, he had had no knowledge, nor had he ever heard of it until he saw it mentioned in that article. He had no connection with it, and knew nothing of it. When visiting the Zander Institute he was shown the case-book, and the record which was kept. He saw several of the people who attended on the patients: they appeared to be qualified persons. He was not brought up as an electrician, but had studied electricity as a phase of knowledge required by medical men, and therefore, not being thoroughly trained in the subject, he might have used terms which were not rigidly correct when interpreted by scientific experts. He had no previous experience with the use of Harness's belts, and his representation was solely from experiments he had carried out. He believed that the article had had a bad effect upon his practice.

In his cross-examination by **Mr. Walton**, the facts were elicited that Mr. Harness was finding the money for the purpose of conducting the case; that Dr. Tibbits was bankrupt in 1891, and had previously made an arrangement with his creditors, which arrangement was not carried out. A lengthy examination of his connection with the West-end Hospital and the West-end School brought out the fact that the school was founded by himself and a brother practitioner; but after a short period they separated, and the school was bought by his (Dr. Tibbit's) wife, who paid his colleague out. The hospital was managed by a committee, and the committee gave permission to the students of the school to attend the hospital and to receive lectures therein. After some questions relating to Mr. Harness's invitation to report, and to the Bloomsbury case, the question of the belts supplied to him was considered. It was stated that he had been supplied with one which had metallic connections, and that, so far as he understood the attachment—which we might term for our purpose terminals—attached to the belt were not for the purpose of connecting it with stationary batteries, but for the purpose of connecting by a metallic cord.

[A rather severe cross-examination followed as to the experiment upon which he relied to prove that the current generated by the belt really passes through the body. Of course, it is impossible for us to comment at the present time upon this experiment—we can only give a summary of the statements elicited during the examination, and given in the report in which Dr. Tibbits adhered to the scientific value of his experiments. The diagram, Fig. 1, although not an exact representation of that shown in the evidence, will enable our readers to understand the experiments; A, B, C, represents the belt as worn upon the body, excited by the natural perspiration, A and B being the poles of the belt. The line joining A B represents the skin of the body between the poles of the belt; E represents an insulated needle inserted through the skin, G the Thomson galvanometer.]

Briefly, **Dr. Tibbits** contended that the current indicated by the galvanometer was generated by the belt and passed through the body, the cross-examination going to elicit the view that the belt played no electrical part in the indications of the galvanometer.

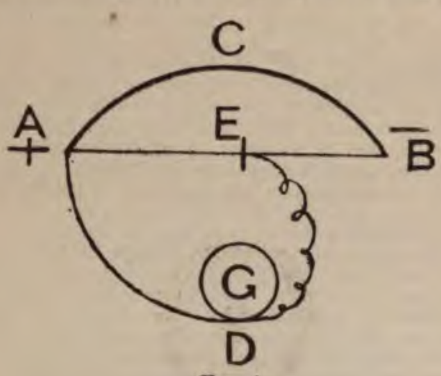

FIG. 1.

In his report he had stated that the belt could be connected up for intensity or for quantity, and he now explained that the references were to the belt when *not* worn upon the body, and that when worn upon the body the result would be the intensity of one couple with a quantity of one or several, according to the connections. He maintained that the only question was, when current went through the body, the best dosage for therapeutics. There was no question as to intensity or quantity; the only question was the one of the current going through the body. In the belt tested, according to the joining up, he got increased quantity, though no increase of potential.

Dr. Arthur Harries gave evidence to the fact that he had made a number of experiments with the belts, and that the current went through the body. In his cross-examination, he contended that the connections on the belt were not for connecting the belt to an outside battery, and that the quantity that went through the body was a variable one, depending upon the resistance, and that the resistance varied from 60,000 ohms to 1,200 ohms. He stated that in ordinary usages of electricity for medical purposes to the body, that from two to five milliamperes might be used for a length of time not exceeding 15 minutes, and that the belt he experimented with gave two-tenths of a milliampere, and might therefore be continued for a much longer period than 15 minutes.

Dr. Russel Harris had made a special study of electricity, and had inspected the apparatus at the Medical Battery Co.'s premises. He had carried out experiments and given a report on the electropathic belts, and he was sure that electricity passed through the body. It was elicited, however, that his proof of this was merely the connecting of the belt with the galvanometer and obtaining a deflection thereon.

Mr. J. W. Wilson, the principal of the Crystal Palace Engineering School, was next examined. He had asked for and received an electropathic belt, which he had worn and derived benefit thereby. Finding it beneficial, he had written to Mr. Harness, and subsequently was asked to report professionally. The belt with which he was supplied at first had no connecting cord as supplied, and seeing this, he had written for the necessary connections, which were sent separately. Asked as to certain experiments referred to in his report, he admitted that he was mistaken.

Mr. Henry F. Joel was next examined, and said he was an electrician of 25 years' experience, and was formerly assistant to the late Sir Charles Wheatstone. Mr. Joel's evidence was given as that of an electrician pure and simple, with no knowledge of the medical part of the case. He stated that he had experimented with a variety of these belts for a period of about seven months, that each belt certainly gave current, and that according to his experiment the current generated, when worn upon the body, went through the body. He had at first experimented with an artificial body, but finding this unsatisfactory, he had worn the belt himself and so carried out his experiments. He explained that the largest current he had obtained was from the belt known as the C belt, from which he obtained two-tenths of a milliampere. The methods by which he had carried out his experiments and obtained his results were described and are fully set forth in his report published by the Medical Battery Company.

Mr. S. J. Mackey said he was the science correspondent of the *Standard*, and had made a number of experiments with these electropathic belts. For the purpose of such experiments he had worn three belts, his conclusions being that the belts gave a current, and that the current went through the body. The quantity he gave as 1·4 of a micro-ampere.

A large number of witnesses were in attendance to testify that they had obtained benefit by the wearing of these electropathic belts, but Mr. Justice Mathew ruled that this evidence was not germane to the case, and so with the evidence of Mr. Mackey the first day's proceedings terminated.

On Thursday, **Mr. Lawson Walton, Q.C.**, opened the case on behalf of the defendants. In his opening speech he referred to the founding of the *Electrical Review*, and to the proprietors of that paper, pointing out that Mr. Gatehouse and Mr. Kempe were more closely connected with the scientific department, and that they had considerable experience in the subjects upon which they had occasion to write. They were perfectly able to form an opinion; they claimed to have found an honest and dispassionate opinion, and one which did not go beyond the domain of fair criticism in the article upon which this litigation was based. They had a perfect right to consider, and, if necessary, to condemn apparatus which was new to the public, and which was put forward as scientifically constructed and capable of giving certain scientific results, and such criticisim ought not easily to be put aside. It was true that Dr. Tibbits was a plaintiff in this action, but a careful consideration of the article would show that there would be a good deal of difficulty in tracing any direct reference to Dr. Tibbits, the article being condemnatory of the belts, which were honestly believed to be ineffective. Journals of the kind conducted by the defendants had a duty to fulfil to the public. He should call attention to the connection between Mr. Harness and Dr. Tibbits. It would be noticed that Dr. Tibbits individually complained that he had connected his name with the sale of worthless apparatus—that it was only incidentally that any reflection was made upon him and only through this connection. There was nothing in Dr. Tibbits's pamphlet to show it was anything but purely voluntarily contributed, yet the examination had shown that he had been paid a professional fee to report upon the apparatus. His letter (which was read at length), was stated to be more of the nature of a voluntary document than of a report. Dr. Tibbits had lent the weight of his authority to the furtherance of this apparatus, and had had a draft of the pamphlet sent to him suggesting alterations of type, and the insertion of experimental details it seems had been left out. It was contended that the connection between Mr. Harness and Dr. Tibbits was really more close than the ordinary letter showed, in that, on the one side, Mr. Harness had belts to sell, and, on the other side, Dr. Tibbits was anxious to have his forthcoming book well advertised in order to sell that. Quotations were given from the edition of the book in 1889, wherein the opinion was stated that galvanic belts were not of any great service. It was pointed out that Mr. Harness was the real plaintiff, and that he had not been called to corroborate Dr. Tibbits's statement in any way. The pamphlet referred to in the article was sent to the offices of the paper in the ordinary course and was criticised in the ordinary way, the critics having to consider the statements in the paper and the apparatus as generally sold to the public. They could only gain their information of the belts advertised and referred to in the pamphlet as they were sold by Mr. Harness, and he contended that the criticism was justified, and that Dr. Tibbits had ignorantly or negligently lent himself to the sale of these appliances, which he held to be unscientifically constructed and not suited for the purposes for which they were advertised. The special points in the pamphlet which were relied upon to show the justifiable character of the criticism were next examined, and it was again urged during the examination of the text of the article that he did not transcend the bounds of fair criticism.

Lord Kelvin was the first witness called, but before his evidence was admitted, **Mr. Bear** was called to prove the purchase of the belt which Lord Kelvin had examined. Mr. Bear stated that he had purchased the belt on September 29, 1892, for five guineas. He had taken it to the offices of the *Electrical Review*, and after examining the belt recognised it as the one he had bought. He got a receipt for the money paid, and remembered that a number of pamphlets were in the parcel, but the exact nature of these pamphlets he did not know, as they had been left with the defendants. He was asked whether the leaflets and pamphlets which were packed up with the belts did not include one containing directions to those who were to wear the belts, but he could not recognise the leaflet nor had he read it.

Lord Kelvin then gave evidence that the belt submitted to him was not in its present condition capable of generating any electricity if worn upon the body. He had seen a copy of Dr. Tibbits's pamphlet, and stated that the term intensity was not scientifically proper. He gathered that the wording of the pamphlet indicated that somehow or other there could be a change of quantity or intensity, but it was not possible to couple up the discs to obtain these changes of intensity. The words, therefore, were not used in that proper sense, because they spoke an impossibility. Assuming that the externals of the metallic connections were properly made, there would be a current, but it would be extremely small. Examined upon the experiments illustrated in Dr. Tibbits's evidence, he pointed out that the currents in the galvanometer would be due to electrolytic action of the moisture of the body between E and A, and that the belt, with the exception of the contact-piece at A, might have been eliminated altogether without the alteration of the galvanometrical indications. The belt was useless, except the pole A and the disc connected with A. The current produced was produced by the test, and did not exist before the test was made. There was no proof of any current through the belt. There was no tapping, for to obtain tapping there must have been two metal contacts, connected with a separate galvanometer. In his cross-examination he admitted that if a piece of zinc was placed in the mouth and a piece of copper placed in the hand and metallically connected, there would be a current through the body, and also there might be a small current through the body when the belt was used with proper metallic connections. Attention was called to another experiment conducted by Dr. Tibbits in connection with a newly-killed rabbit where two contact-pieces were used, and it was acknowledged that this was the proper way to carry out the experiment, but that this experiment was not described in the original pamphlet.

A somewhat lengthy legal discussion now took place as to the admission of evidence of purchasers of belts, but this was ruled out.

Mr. Gatehouse, when examined, acknowledged his responsibility for the article in question. His attention had been directed to these belts some time ago, and he wrote about the belt as he knew them to be sold, and without any personal knowledge of Mr. Harness or Dr. Tibbits. He had given evidence in the Bloomsbury case about these belts. In the pamphlet which was criticised no diagrams were given, but only a description of the experiments. He honestly believed what he had stated in the article. He had carried out a number of experiments with belts, and had received at various times a number of pamphlets, but although he had looked through them he had found no instructions as to this metallic coupling. The only reference to the sockets visible upon the belts, so often mentioned in this case, was found in a pamphlet which stated that they were for the purpose of connections with the terminals of a stationary battery. The quantity of electricity generated by the use of these belts varied according to the moisture of the skin, and was a very small quantity—from one-hundredth to one four-hundredth of a milliampere, and he considered that there were several paths open to the current thus generated: the surface of the skin, the webbing of the belt, the underclothing of the person, and probably a small portion through the body. In his cross-examination, he adhered to the paragraph read from the *Electrical Review* of July 29th, that when properly connected there was practically no current through the body, and expressed his agreement with Lord Kelvin's evidence. He stated that he had not accepted the invitation of Mr. Harness to visit the institution in Oxford-street. He acknowledged his acquaintance with Pulvermacher's belt, and that by their use a current could be obtained which passed through the body.

Mr. Kempe then gave evidence. He said that he had no personal knowledge of Dr. Tibbits; that he had read and discussed the pamphlet with his colleague, Mr. Gatehouse; and that he honestly believed all the things which had been stated in the article. He agreed with Lord Kelvin's evidence, and made many independent experiments. Under favourable conditions he thought the current might be as much as one-tenth of a milliampere, but ordinarily not more than one four-hundredth or one five hundredth of a milliampere, and this he termed a trace of current, but the current detected at first would soon be diminished by polarisation due to the formation of hydrogen and back E.M.F. In his cross-examination, he contended that the hydrogen could not be rubbed off the disc.

Mr. Swinburne then gave evidence, and declared that his examination of the pamphlet had led him to the view that the writer was incompetent.

Prof. Silvanus Thompson also gave evidence very much to the same effect as that of the previous scientific witnesses—that without the metallic connection there was no current, and that connected there might be a current, but that in whatever way the discs were joined a greater effect could not be obtained; that even when all the discs were coupled in parallel the current obtained was extremely small, and under the best conditions would not be more than one-fifth of a milliampere. Under the ordinary conditions, however, with a dry skin, he thought the current would not be more than one two-hundredths of this, and that no doubt a good part of this infinitesimal current would go through the body. Asked as to his views obtained by reading Dr. Tibbits's pamphlet, he stated that he should have called him a dear old doctor who does not know what he is talking about, the opposing counsel interpolating the remark that that would not have been libel.

Dr. Watteville next gave evidence. He had had considerable experience with these belts, and produced one which he said had been worn, and which showed no traces of corrosion. In his cross-examination, however, he admitted that there was a slight trace of corrosion at the contact of the metals.

Dr. Jones also gave evidence agreeing generally with Lord Kelvin. He stated that in his practice the dose was from 2 to 10 milliamperes for most cases, continued for about 10 minutes.

Mr. Tunzelmann agreed generally with the scientific evidence that had previously been given. He had come to the conclusion, after reading the pamphlet, that the author knew very little about his subject. He pointed out that the Thomson galvanometer was sufficiently delicate to indicate that there was a current when the circuit was made through or by two pieces of the same metal, because no pieces of metal would be exactly similar.

Mr. J. Gray gave evidence on experiments he had carried out with belts as to polarisation. In one case with the belt he had worn he got a small current at first, but after wearing it 12 hours the current fell to half. In the second case the current was larger at starting than at the first case, but after 12 hours he could not detect any current.

Mr. Segundo gave evidence as to the purchase of a belt, and that the attendant who sold him the belt stated that the contact-pieces were to make connections with the primary battery.

This finished the evidence for the defendants, who did not call a number of witnesses they had present.

Mr. Walton then addressed the jury on the evidence for the defence, and the proceedings of Thursday terminated.

We shall give his address, with the address for the plaintiff, and the summing-up of the judge, together with the verdict, next week.

Smokeless Mechanical Stoker.—The St. Clair circular mechanical stoker has been applied, we are told, to over 1,200 boilers, amongst which are mentioned two for the Bradford Electrical Company. Great economy is claimed, and the makers—the St. Clair Mechanical Stoker Company, of Broughton Bridge, Manchester—offer to put down stokers on approval. A self-acting damper is recommended for use with the stoker to push the belt on the loose pulley. The London office is 19, Laurence Pountney-lane.

TRADE NOTES AND NOVELTIES.

MAY'S WATCH-SHAPE REVOLUTION COUNTER.

Where machinery is running, it is frequently necessary to determine the number of revolutions. Although many speed counters are in the market, there is a field for a portable instrument which reads accurately and reliably. If it cannot easily get out of order, nor be damaged by rough handling, and, most important of all, can be easily read by anybody in the engine-room, skilled or not, then there is a clear recommendation in its favour. May's new patent revolution counter has been constructed to meet this demand. It is made in the shape of a pocket watch, and is therefore conveniently portable. The watchcase keeps the works well protected and clean. To secure an easy reading the face is silvered, and the figures are bold and black. The revolutions are read off a dial like on a watch by two arbors, the long one reading units and tens, the short one reading hundreds. The instrument is so constructed that whichever way the machinery revolves, to the right or left, it is direct-reading. There is a disc under the face with a double set of figures, and these figures become visible through the apertures in the face automatically, in accordance with the direction in which the spindle revolves. Fig. 1 shows the spindle turning to the right, whereas in Fig. 2 the direction is to the left. It is obvious that both figures read 738 revolutions. By a key inside the back cover, both arbors are easily brought back to zero. The price has been kept very low, being not much more than a Waterbury. Messrs. O. Berend and Co., of 61, Fore-street, are the owners of the English patents.

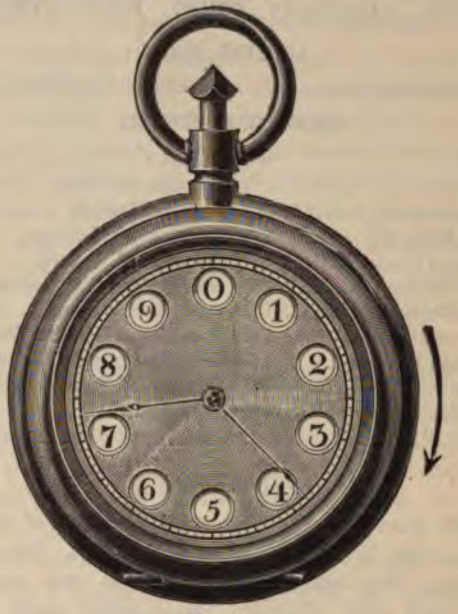

Fig. 1.

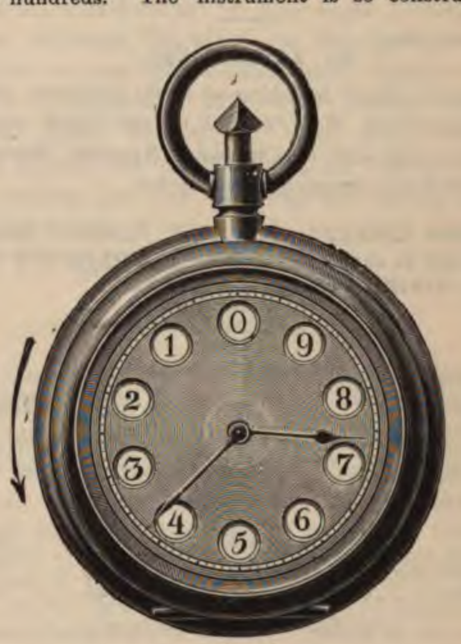

Fig. 2.

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UNACCOUNTED FOR.

We are glad to see that the Westminster Supply Company has had the courage to admit that a certain proportion of the current generated cannot be accounted for. It has long been recognised in gasworks that a certain part of the gas made is lost. Such loss is generally attributed to leakage. In fact, in gas management leakage plays an important part in the economy of production, and a similar loss will play its part in central-station working. From the report it will be seen that 1,477,131 units were generated, and of these 1,217,871 units were sold, leaving 259,260 units generated and not sold. Of these a part is used in the works, and may be taken to form a necessary part of the cost of production. There is also a loss in the feeders. This is a loss which cannot be avoided, though it ought to be minimised. There is, however, in addition to what can be accounted for, a loss of 46,690 units—a little over 3 per cent. This we take to be an excellent result, for direct and indirect information from other sources leads to the conclusion that the units generated and not accounted for are usually a greater percentage than this. We have contended that, from the investor's point of view, the cost of generation must be taken to include all expenditure, and thus in this case the cost of getting 1,477,131 units is £24,834. 4s. 10d., or about 4·035 pence per unit. Now take the Newcastle and District report. Unfortunately, we get only the units supplied, not generated. Assuming that the losses in both cases are similar, we may assume that about 337,000 units have been generated at Newcastle at a cost of barely 3d. per unit, but we cannot get the same definite results from the Newcastle as from the Westminster balance-sheet. The difference in cost is slightly over 1d. in favour of Newcastle, and this is, of course, largely or wholly due to the difference in price of fuel. However, our aim is not so much to compare the cost per unit of Newcastle and London, as to show that, from published balance-sheets, where the total cost of generation, distribution, and management is concerned, the result is sufficiently low to prove that the business must be remunerative. At Newcastle the cost is 1d. per unit less than in London, but the consumer gets the benefit of the lower cost in paying a lower price per unit. Of course we are bound to admit that *the* most important questions in central-station management are "cost of generation per unit" and "unaccounted for units." The loss in the mains approaches to a constant—the cost of management is fairly constant. It is a pure question of good management and of good engineering that the units unaccounted for are small compared with the units generated. Thus the larger the business the nearer does the total cost per unit approach to the generating cost per unit. Therefore it would be useful information for central-station engineers if all balance-sheets contained a table similar to that of the Westminster Company, and there should be great emulation to keep the unknown loss at the lowest possible figure. Is 3 per cent. too high, or is it fairly low? are questions that cannot satisfactorily be answered till we have complete and authentic statistics from many more stations.

LOCAL INFLUENCE.

A great deal of influence one way or another can be exercised by a single person in electrical as in most other questions. Sometimes this is done by an enterprising electrical engineer pushing the new illuminant, sometimes by a gas director bitterly opposed thereto. But it has been left for Heckmondwike to discover the influence of the local lamplighter on the future of electric light. It will be remembered that the Heckmondwike Board, after long discussion, resolved to adopt the electric light for the town. But opposition was not wanting, and a meeting of ratepayers was called, at which it was decided to move that the resolution should be rescinded. A poll was called, and the reactionists won by thirty-one votes — electric light for Heckmondwike was doomed. Mr. S. Wood, the most active advocate for electricity, has now discovered that a lamplighter named Starkey, who was by a curious error of judgment sent round with the voting-papers, had canvassed and exercised his influence against the electric light, no doubt justly fearing the simple switch would do away with his work. Mr. Wood, indeed, expressed the belief that the result had been reversed by the man's influence, and severely condemned his conduct. He suggested that the electric light question should be made a leading topic at the next election, and the chairman of the Board accepted the challenge. After this, the advocates of electric light will know where to look for active opposition.

THE TELEPHONE COMPANIES.

It is seldom that we feel in any way obligated to attempt a correction in a statement made by contemporaries, but our esteemed contemporary the *Electrical Review*, in its last issue, seems to have made a less careful examination of the position of the telephone companies and the policy they are—or rather it is—carrying out than is usually the case. We are all of us at times apt to accept information as complete which, to say the least of it, is hardly up to date. Its last sentence is a very strong condemnation to the effect that "the system proposed by the New Telephone Company is old; has been tried, and failed; and no evidence has been forthcoming that the causes of failure have been eliminated."

Unless our memory serves us incorrectly, this was practically the standpoint that our contemporary took in criticising the proposals of Mr. Bennett as put forward at the British Association. Our latest information upon the subject is to the effect that the National Telephone Company is working as energetically as possible to convert their Glasgow exchange—which is the largest they possess after London—to the "Mann" system, and, moreover, that they are erecting in Glasgow a multiple switchboard which is practically identical with the one fitted up by Mr. Bennett, in Manchester, for the Mutual Telephone Company. As we have stated, unless our reference and memory are defective, it is this switchboard which our contemporary decided, after the reading of the British Association paper, could not possibly work. Further, the telephone company contemplates similar changes in other towns besides Glasgow, the success of the system at Manchester having exceeded all expectations. The National Telephone Company are also at work converting a portion of their City of London subscribers' lines to metallic circuits—a work which, as our readers know, we have always contended was urgently needed, and would do much to get rid of the troubles prevalent over the telephonic system as given to us in London. The company are also giving effect to other recommendations as put forward by Mr. Bennett in his paper. This ought to have been expected, in that Mr. Bennett threw in his lot with the New Telephone Company by the amalgamation with the National Telephone Company, so if his views were even approximately correct, that action would naturally imply that the company intended carrying out his views. That they are doing so is proof positive that his influence has been felt.

We have also to refer to our own article on the question of Telephone Company *v.* Baker at Leeds. A correspondent has called attention to some of our remarks, and we agree that he is correct in his contention that we should not credit the lawyers with so great a desire to promote litigation. We have had a good deal of personal experience of legal opinions, and this experience should have led us to have been more cautious in attributing to the legal profession a desire to increase litigation, as the opinions have invariably, in our experience, been against rather than for litigation. We still incline towards the view that, whether a legal point was in question or not, the analogy was so imperfect that it was useless for the purpose for which it was brought forward.

REVIEWS.

Domestic Electric Lighting Treated from the Consumer's Point of View. By Ed. C. de Segundo. Alabaster, Gatehouse, and Co.

It is held by some people that because they are well-informed on a subject, everybody else is also; that all is well known, even down to the proverbial schoolboy. Unfortunately, the world is too busy nowadays for more than one here and there to become fairly conversant with any subject; and it is wonderful how little electrical information has as yet permeated to the mass of householders. Mr. Segundo tells them of electric lighting in simple language, free from much that is technical, yet sufficiently so to give that modicum of information which one who desires to obtain the electric light wants to know. There is, however, much even of this little book that might, we think, with advantage be omitted. It matters little to the user whether the system of distribution is high or low pressure; the danger from the former can hardly be said to appeal to the user, because, so far as he is concerned, the pressure is simply the lamp pressure—say, 100 volts—unless he can tamper with the primary circuit of the transformer. This is usually impossible, hence dangers arising from high-pressure distribution are outside the users' ken, though they may very justly be considered from the producers' and distributors' points of view. Our opinion is that the user should be told all that concerns him and nothing more. Still, this is a matter of opinion only, and does not detract from the value of the book. We should welcome any book, and like to see it widely distributed, that preached sermons upon such texts as "a source of economy is found in the electric light, in that for an equal total practical illuminating effect the lamp hours required under electric lighting are less than those under gas, and considerably less than those under oil," p. 23. On p. 79 is another text worth dwelling upon. "The moral of this is, that people whose houses are lighted by electricity should not make any indiscriminate additions of lamps without consulting some competent individual as to whether the wires can stand the extra intensity involved." These quotations will show that the book contains a good fund of common-sense advice, and must therefore be of service if generally read by householders.

DYNAMO BRUSHES.

The note which we gave last week on dynamo brushes, constructed of very thin plates, is the occasion of an additional note by M. Eric Gérard in *L'Electricien.* The chief function of the brushes, says M. Gérard, is to collect the current. They have often a supplementary function, that of correcting the sparking due to lack of proportion in the machine, or to the effect of a too variable current. To fulfil the first function, the simple copper strip is sufficient. Various solutions have been proposed for the second, all embodying the introduction of a resistance sufficient to prevent the current attaining an exaggerated amount. Carbon contacts offer a desirable solution for certain motors. The resistance of the contact is then generally greater to that of the armature sections; whence the possibility of shifting the brushes over a considerable space without sparking. The neutral line is obtained by seeking the point giving the least sound. This explains the success of carbon brushes for motors which are required to reverse. But by reason of the resistance offered by the contact between carbon and commutator, a fall of potential is produced which is by no means negligible; this leads, in dynamos giving large currents, to a considerable degree of heating and diminution of efficiency: with high-tension machines or with low currents these inconveniences do not exist. Another solution consists of employing metallic contacts with superposed plates. When two successive segments of the commutator are in contact with such a contact, the current of the commutated segments is obliged mostly to go up the plates to the point of soldering, consequent to bad contacts of the plates amongst themselves. This effect is greater as the plates are more numerous, and if the plates are made of a metal of only moderate conductivity, such as German silver or brass, the intense extra currents are avoided. A similar result could be obtained by connecting the armature coils to the commutator by conductors of such metals. The use of thin plates has the advantage, for dynamos subject to vibration, of reducing the tendency of the brushes to leave the commutator.

PHYSICAL SOCIETY.—February 10, 1893.

ANNUAL GENERAL MEETING.

Mr. Walter Baily, M.A., Vice-President, in the chair.

The reports of the council and treasurer were read and approved, copies of the balance-sheet being distributed to members. From the former it appears that the society now numbers 371 ordinary members and 12 honorary members, and that during the past year the society has lost six members by death—viz., the Rev. T. Pelham Dale, D. J. T. Hurst, B. Loewy, C. E. Walduck, G. M Whipple, and P. W. Willans. Obituary notices accompany the report. The treasurer's statement shows the financial condition of the society to be satisfactory.

A cordial vote of thanks to the Committee of Council on Education for the use of the rooms and apparatus of the Royal College of Science was proposed by **Mr. Shelford Bidwell**, seconded by **Mr. Blakesley**, and carried unanimously. A similar vote was accorded to the auditors, Mr. H. M. Elder and Mr. A. P. Trotter, *on the motion* of **Dr. Gladstone**, seconded by **Prof. S. P. Thompson**. **Prof. Ramsay** proposed a vote of thanks to the officers of the society for their services during the past year. This was seconded by **Prof. Fuller** and carried. **Prof. Perry** responded.

The following gentlemen were declared duly elected to form the new council: President, Prof. A. W. Rücker, M.A., F.R.S.; vice-presidents, Walter Baily, M.A., Major-General E. R. Festing, R.E., F.R.S, Prof. J. Perry, D.Sc., F.R.S., Prof. S. P. Thompson, D Sc., F.R.S.; secretaries, W. M. Elder, M.A., 50, City-road, E.C., and T. H. Blakesley, M.A., M.Inst.C.E., 3, Eliot-hill, Lewisham, S.E.; treasurer, Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey; demonstrator, C. Vernon Boys, F.R.S., Physical Laboratory, South Kensington; other members of council: Shelford Bidwell, M.A., LL.B., F.R.S., W. E. Sumpner, D.Sc., Prof. G. Fuller, J. Swinburne, Prof. J. V. Jones, M.A., Rev. F. J. Smith, M.A., Prof. G. M. Minchin, M.A., L. Fletcher, M.A., F.R.S., Prof. O. Heinrich, Ph D., F.R.S., James Wimshurst.

In response to invitations for suggestions regarding the working of the society, **Prof. S. P. Thompson** said all must appreciate the efforts of the late council, and particularly of the honorary secretaries, in making the society better known. But he could not help thinking that there were many persons amongst teachers of physics and scientific amateurs, whose active sympathies it was desirable to engage, who were not yet associated with the society. Perhaps the time of meeting was not convenient for all, but he thought much might be done by freely circulating particulars of what was going on at the meetings. The daily papers merely announced the meetings, but said nothing as to the place of meeting or the papers to be read. In his opinion the society did not take the position in the scientific world to which it was entitled, and he wished to inspire members with a determination to bring its claims prominently forward.

Mr. Blakesley pointed out that almost all the scientific and technical papers gave full announcements of the meetings and of the papers to be read.

Mr. W. F. Stanley said Friday afternoon was not convenient for scientific men engaged in trade.

The meeting then resolved into an ordinary science meeting, and Mr. C. E. Grove was elected a member of the society.

Dr. J. H. Gladstone read a paper on "**Some Recent Determinations of Molecular Refraction and Dispersion**." The paper related to the new metallic carbonyls, the metals iridium and gallium, sulphur, and to liquefied oxygen, nitrous oxide, and ethylene.

Mr. E. C. C Baly made a communication on "**Separation and Striation of Rarefied Gases under the Influence of the Electric Discharge.**" On examining with a spectroscope a vacuum tube containing a small quantity of hydrogen, the author noticed that the hydrogen lines were strongly visible in the negative glow, but could not be seen in the body of the tube. This observation was confirmed by examining other tubes, and seemed to point to a separation of gases in the tube. From subsequent experiments it also appeared that the striæ were due to this separation. By using a double tube containing a mixture of carbon dioxide and hydrogen whose parts were connected by a narrow neck which could be sealed and the parts detached, the gases were fractionated by the discharge. After sealing off, the spectra of the two parts were examined; the one that had formed the positive pole showed only a trace of hydrogen, whilst the other showed it brilliantly. Other mixtures gave similar results, and the separation was found not to depend on the relative molecular weights of the gases. A very close connection between separation and striæ was noticed, the two phenomena always occurring together. On using a tube with a very minute negative electrode, to avoid the negative glow, neither striation nor separation took place, but on reversing the current so as to make the large electrode the negative one, both phenomena became well marked. If the author's views were correct, a pure vapour or gas should not striate. Pure mercury vapour gave no striæ, but on allowing a small quantity of other gas to pass into the tube they at once appeared. Pure vapours of iodine, sulphur, arsenic, and mercuric iodide gave similar results. Attempts to prepare a tube containing pure hydrogen which should not striate were not perfectly successful, but the striations usually seen in hydrogen tubes were reduced so as to be barely distinguishable. The author therefore concludes: (1) When an electric current is passed through a rarefied mixture of two gases, one is separated from the other and appears in the negative glow. (2) That striæ are caused by the separation of the two gases, and do not occur in a single pure gas or vapour. **Mr. Blakesley** read a communication from Dr. W. Crookes relating to Mr. Baly's paper, and pointing out that in his presidential address to the Institution of Electrical Engineers, in January, 1891, he had given reason for believing stratification due to the gas not being homogeneous. He had also shown that the character of the stratification depended on the potential of the discharges. **Prof. Ramsay** said no proof had been given that electrolysis occurred in such tubes, and it was an open question whether molecules would convey electricity as ions do. So far as was seen, no ions existed in vacuum tubes. Possibly the stratifications resulted from collisions of molecules giving higher temperatures at some parts of the tube, but this was doubtful. **Mr. Enright** thought the analogy with electrolysis was not quite clear, for in a mixture of single gases the elements were not combined chemically, and electrolysis involved the splitting up of chemical compounds. **Prof. S. P. Thompson** hoped the author would continue his important work, and clear up the doubtful points in vacuum-tube phenomena. Some difficulty existed in classifying the separation of the gases with electrolysis, for in the latter the effects were only visible at the electrodes and not in intermediate portions of the substance. The question whether vacuum tube discharges were strictly analogous might be tried by fractionating through more complicated tubes. Prof. Schuster had considered the analogies in his Bakerian lecture, and published some important results, some of which tended to show that wanderings ions existed in vacuum tubes through which discharges were being passed. Referring to Prof. Ramsay's remarks about molecules not carrying electricity, he (Prof. Thompson) said that electric winds were phenomena which pointed to the opposite conclusion. Similar convective action also occurred in turpentine and other insulating liquids. He wished to know whether the author had tried if a low voltage (say, 100 volts) applied for a long time to a vacuum tube would produce separation of the contained gases. Porret's phenomena of electric osmose seemed to have some bearing on the subject, as also Faraday's observations on the movements of scraps of silk in turpentine, and showing that in non-conducting liquids there were phenomena somewhat analogous to electrolysis. **Prof. Ramsay** said that if indigo were but put in a poor conductor, such as distilled water, and the mixture subjected to electrolysis, all the blue colour became concentrated about one electrode; whilst if arsenic sulphide be similiarly treated, the colour went to the other pole. On mixing the two solutions all coagulates and goes down. He could give no explanation of these remarkable effects. **Mr. Blakesley** enquired whether tubes which had been kept some time showed the same phenomena as immediately after sealing? In his reply, **Mr. Baly** said the striæ in some tubes had very peculiar shapes, some showing discs and others showing cones alternately base to base and apex to apex. He had tried the experiment with complicated tubes, as suggested by Prof. Thompson, but the result was not conclusive.

COMPANIES' MEETINGS.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

The sixth ordinary general meeting was held yesterday at 1, Great George-street, Westminster, under the presidency of Mr. Granville R. Ryder. The notice calling for the meeting having been read,

The **Chairman**, in moving the adoption of the report and accounts, said that he thought the accounts showed a substantial and steady progress, though perhaps not so rapid as they might wish. At the same time, there were some features of an encouraging character. In the first place, the number of shops and houses taking light on the 31st December, 1891, was 436, and these had increased to 550 at the close of 1892, whilst the lamps of 8 c.p. had advanced in the same period from 38,408 to 47,441. The output in units had augmented from 385,051 at the end of 1891 to 535,343 at the close of 1892, but the gross earnings had practically remained the same, being 7s. 7d. per lamp as against 7s. 8d. in 1891. With regard to the gross earnings, in 1891 they amounted to £12,263 and last year to £16,628, being an increase of £4,361. The net profits had increased by £2,446—that is, from £4,381 to £6,828. It was satisfactory to note that the ratio of profit to gross receipts had advanced from 36 per cent. to 42 per cent in 1892. The capital expenditure had reached £12,800 in round figures, and the main items of that comprised buildings, coal bunkers at the Knightsbridge station, which would tend to more economical working, batteries, laying of mains, meters, plant, and mains. The shareholders would doubtless observe that there had been a considerable increase in the capital account, that the mortgage debentures issued last year amounted to £29,400, whereas in the account for 1891 the sum was £7,930. On the other side of the account there was suspense account and law £1,800. That was due to the action brought against the Company by Mr. Lane Fox. As they were aware, they did not have to bear the whole of the expenses themselves, as other companies and also some private firms joined in with them. The total cost of that action was over £6,000, and their expenses were about £2,000. They had gained a victory over him, and Mr. Lane Fox was condemned in costs, but at the present those costs had not been paid. Whether they would be paid or not he could not say, but negotiations were proceeding which might result in the money being handed over. The actual amount he would have to pay was about £1,300. A highly satisfactory item was the first in the revenue account. They would observe that the manufacture of electricity, coal, water, wages, etc., cost £3,746. Last year the amount for the same items was £4,067. They would thus see that with an increase in the output of one-third, they had actually reduced the expenses of production by something like £300. That reflected great credit upon their staff Concerning the district which the Chelsea Electricity Supply Company had agreed to sell to them, it was producing gross receipts of £1,700, and he would be surprised if out of that they did not get from 10 per cent. to 12 per cent on the purchase-money, which was £7,000. With regard to their fees, the Directors, up to the end of 1891, had received them in shares. He then moved the adoption of the report and accounts.

This was seconded by **Mr. G. H. Hopkinson**, and was adopted.

Mr. Wylie proposed, and **Mr. Saunders, Q.C.**, seconded, that £350 should be granted to the Directors for their services during the past year. This was carried.

The dividends recommended being adopted, Mr. G. H. Hopkinson was re-elected a director, and Mr. Granville R. Ryder was appointed chairman. The auditors were then re-elected, and the proceedings terminated.

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

In our last issue was published the report and accounts of the above Company. It was then mentioned that an exhaustive report by the auditors accompanied the balance-sheet, and that it imparted the fullest information concerning the various items. The auditors' report is as follows:

In accordance with instructions received from your Directors, we have prepared from your books a trade and profit and loss account, showing the result of your trading during the 12 months ending September 30, 1892, together with a balance-sheet on that date, and we now beg to submit to you these accounts duly signed, subject to this report. The loss which is shown in the accounts is due principally to the great difference in the estimated values of stock and plant as now taken, and as taken in the balance-sheet at 30th September, 1891. It may, of course, be thought that the stock and plant have this year been taken at too low a figure, but we think the Directors have acted wisely in adopting this course. In the following explanations as to the accounts you will find that a sum of £20,000 has been written off from the book value of patents, patent rights, goodwill, etc., as taken over by the present Company, and as this figure originally stood at about £200,000, we scarcely think it is too much; in fact, the question is whether it would not be wise to write off even a much larger sum. You will also find that the whole of the amount appearing in the books as the value of patterns and drawings has been written off, and it may be said that in this respect the assets of the Company have been unduly depreciated, but under all the circumstances we think the Directors are wise to write off what is to a certain extent, and with certain exceptions, a fictitious value. You will observe from the trade and profit and loss account that the actual net loss during the year was £69,281. 16s. 4d., but in looking at this figure it must be borne in mind that it is very largely made up of amounts written off for depreciations, and the writing down of the book values of stock and plant generally. The above figure of £69,281. 16s. 4d. is made up of the following items—viz.:

	£	s.	d.	£	s.	d.
Works department –						
Estimated amount written down off stock	15,000	0	0			
Book value of patterns and drawings written off	3,200	0	0			
Estimated depreciation on plant, machinery, etc	2,573	4	5			
Estimated depreciation on office and works fixtures, fittings, etc., and leasehold premises	232	1	0			
Loss on trading, including all expenses, salaries, rent, bad debts, and sundry experiments, etc.	3,121	14	2			
				24,126	19	7
Barking department—						
Loss on this, including all depreciation of stock, plant, rolling-stock, etc				12,309	6	3
Hampton and Chertsey—						
Estimated amount written off stock..	1,000	0	0			
Amount written off launches, charging stations, plant, etc., for estimated excess values and depreciation	1,548	7	6			
Loss on trading, after providing for all expenses of administration, etc,, and bad debts	570	10	3			
				3,118	17	9
Windermere and Liverpool, etc.—						
Amount written off plant, launches, etc., including estimated depreciation during the year	1,508	13	8			
Exhibition expenses at Edinburgh and Glasgow, and including cost of maintenance, depreciation of plant, etc., estimated at	2,500	0	0			
Loss on trading, including all expenses, etc	168	1	7			
				4,176	15	4
Chief office—						
Balance of stamp duty on transfers to Company	482	2	0			
Stamping chemical agreement	100	0	9			
Directors' fees	1,240	0	0			
Salaries of secretary and staff general manager's salary, rent and insurance, accountant's charges, auditor's fees, advertising, stationery, etc.	3,727	15	5			
				5,549	17	5
Capital expenditure account—						
Amount written off book value of patents, patent rights, goodwill, etc.				20,000	0	0
				£69,281	16	4

In looking at the above figures it must be borne in mind that some of them are merely estimates, and that in other cases under the heading of expenses the amounts expended during the first six months of the year ending September 30 last were considerably in excess of the following six months, both so far as the chief office is concerned and also the works. Your Directors have reduced their fees to half what they were entitled to receive during the last nine months of the year, and none of these fees have been drawn. The amount of £39,871. 12s. 10d. appearing in the trade and profit and loss account as estimated depreciation, etc., on plant, machinery, etc., maintenance of Barking and other installations, exhibition expenditure, experiments, etc., is made up of the following items—viz.:

	£	s.	d.
Works—			
Plant, machinery, etc.	2,573	4	5
Patterns and drawings	3,200	0	0
Leasehold premises	71	10	0
Trade and office fixtures	160	11	0
Written off stock	15,000	0	0
Barking—			
Plant, machinery, etc., maintenance, etc., and experiments, and writing down values, etc.	12,309	6	3
Hampton and Chertsey—			
Plant, launches, charging stations, etc.	1,548	7	6
Written off stock	1,000	0	0
Windermere, Liverpool, etc.			
Plant, launches, etc.	1,508	13	8
Exhibition expenses at Glasgow and Edinburgh, experiments, etc.	2,500	0	0
	£39,871	12	10

	£	s.	d.
In the balance-sheet you will observe there are still calls to be made on the preference shares, which, together with the calls already made, but still outstanding, amount to about	26,000	0	0
Add to this sum the estimated value of book debts to be received of	5,658	10	2
Bills receivable in hand	10,468	5	1
And cash at bank and in hand	596	16	11
We have an available sum of	£42,723	12	2

Out of which will have to be paid the following amounts—viz.:

	£	s.	d.
Liabilities as per balance sheet under the heading of sundry creditors amounting to	9,248	14	6
Less creditors on suspense account included therein, which we do not anticipate will have to be paid, unless in ordinary shares	895	15	11
	£8,352	18	7
Balance of purchase of patent for depositing copper	10,000	0	0
Balance of contract for building works for copper business at Millwall, including about £200 for extras	2,900	0	0
Purchase of the necessary machinery for the copper business, which we understand will amount to about	10,000	0	0
These sums together amount to	£31,252	18	7

and when deducted from the amount to be received from further calls, book debts, bills receivable, etc , will leave a sum of about £11,500 as working capital for the business beyond the amount appearing in the balance-sheet as the present value of stock-in-trade. In giving you the above figures we have been desirous of placing before you as near as possible the present position of your Company, and in doing so have stated figures which do not actually form part of your present balance-sheet, although they are engagements which have been entered into, and for which you will receive proper value, yet they will have to be paid for out of your present working capital, which will practically be reduced accordingly.—Yours faithfully,

WARD AND WILDING, Auditors.

The second ordinary general meeting of the Company, after having been adjourned on two occasions, took place on Tuesday at Winchester House, E.C., the Right Hon the Earl of Albemarle, K.C.M.G. (chairman), presiding.

The Secretary (Mr. J. Payne) read the notice convening the meeting, and the report and accounts were taken as read.

Mr. James Pender rose to make an explanation. At the last adjourned meeting he was reported to have stated that the cause of the delay in rendering the accounts was that one of their secretaries had been drowned, and that the last secretary (Mr. Smith) had "gone off his head." Since then the speaker had learned that that was not exactly the case, and that the remarks he had then made were probably made in haste and without thought. He had heard that the late secretary had felt rather grieved, and he thought he had reason to. He therefore begged to inform those present that the real cause of his (the secretary's) absence from work was due to over-anxiety and overwork in connection with that Company. The speaker expressed his regret for the hasty words, and hoped that the explanation would give the late secretary the desire he wished—that an explanation should be made.

The **Chairman**, in moving the adoption of the report and accounts, expressed his regret that the meeting had been so often postponed, but they well knew that serious changes had been made in the staff, and that many of those who took the greatest possible interest in the affairs of the Company had been absent through illness. Lord Egerton of Tatton was suffering considerably at Biarritz, but he (the chairman) had received a telegram from him stating that he agreed to the course which the Directors proposed to pursue Personally, the speaker had been ill for two years, and he had therefore been unable to give that attention *which he had done for many* years to the interests of electric traction. It was for those reasons, and in consequence of the changes in their staff, that they had felt it necessary to have a thorough examination of the affairs of the Company. The report dealt with the matter in a very complete form. It would be observed that the losses were not due to the operations of the past year only ; they were the outcome of former proceedings. It would be old history to refer to the history of electric traction. It was only three years since the present Company began its operations, but the exertions of those who had always been devoted to electric traction dated much further back. It would be noticed that the sum of nearly £60,000 had been written off the capital account in respect of depreciation of plant for the Barking undertaking, and that the patents and goodwill had been written down by £20,000. His Lordship remarked that the shareholders might imagine that the writing down of those amounts implied a depreciation of money, but that was not so. The relative value of the property would remain exactly the same, though the nominal value would be depreciated ; but if they were all right in believing, as they all did, that a better time was coming, they would all share in any advantages which might accrue in consequence of the improvement. The trading account showed a loss of £4,000, but that was due to exceptional causes, which it was hoped would not recur. The expenditure for management might appear high, but the greater portion occurred in the early part of the year, and latterly considerable economies had been realised. The Board had recently made an arrangement with the Electric Construction Corporation, who would for one year undertake the management of the Company for a fixed sum, which represented something less than one-tenth of the amount charged for the expenditure of the past year. That was another good diminution in the expenses, and while speaking of the management expenditure, although the charges for the Directors' fees appeared on the balance-sheet, the Directors had not received anything for the past nine months, and the nominal indebtedness which they still retained upon the Company was calculated at about one-half of what was originally the case, so that the shareholders would see there was no selfishness on the part of the Directors. The Electric Construction Corporation, as a result of the changes they were making, would, the Directors hoped, be able to arrange for the efficient conduct of the Company's business, and the Directors would devise a plan of action for the future which they hoped would lead to beneficial results. The Electric Construction Corporation were, his Lordship remarked, large shareholders in the General Electric Power and Traction Company, and had therefore every interest in the value of the Company. Proceeding to refer to electric traction, the Chairman observed that very little progress had been made. The Directors were confident that the systems they advocated would be of benefit to the shareholders, and although at present in abeyance, they admitted that the hopes they had entertained of that branch had been hardly fulfilled. They had had promises from various quarters, and they had incurred considerable expense in demonstrating the advantages of electric traction. They had seen no reason to change their opinion. Whether it was want of capital or vested interests they did not feel justified in continuing to demonstrate at their own cost what should be obvious, and no doubt was obvious, to those entrusted with the management of the tramway systems. At one time they had an amicable arrangement with the North Metropolitan Tramways Company. They were able, by a long course of experiments, to show that company that there would be a considerable advantage in adopting electricity on their lines. The tramway company had seen their experimental installation, and were so pleased with it that they went to Parliament to acquire the right of using electric power over the whole of their lines. Parliament in its wisdom, whilst allowing the Company to carry electricity on their lines, inserted a clause that the Corporation of the land through which the lines ran should have the veto by which they might cause the cars to be removed in 24 hours. Now, the North Metropolitan Company were very kind to them, the last company (the Electric Traction Company), and they co-operated with the Electric Traction Company in every way, but as soon as they found that they were absolutely at the mercy of the Corporation of the land through which the lines passed, they at once said that it would never do for them to expend a large sum to keep electric traction going. The price at which they (the electrical company) were working was all very well as an exhibition, but as an experiment it was not sufficient to be commercially satisfactory. The line got neglected, and owing to overcrowding, and various other causes, many accidents happened. That was proved by the fact that the line over which they had run was in such a bad state that it had to be entirely remodelled. That did, however, not alter the opinion of the directors that the principle of running a number of cars at a mileage rate was altogether unfair to the electrical contractor. In the course of the experiments they had gained valuable experience, and given an installation of 12 cars with average gross receipts of 11d. per car mile, which was much less than the receipts at Barking during the prosperous time, the installation could be operated at a profit to all parties concerned. It was the opinion of the Directors that the system was superior to horse traction. They had to bear in mind that the vested interests involved must retard the introduction of electric traction, but time and the constant pressure of shareholders in the tramway companies should surely lead to the adoption of electricity throughout the country. When the time arrived they did hope to get their share of the benefits. There was no doubt, that in anticipation of a greater demand for machinery than had been experienced, their late manager had produced more stock than was necessary. Meanwhile they had thought it prudent to write down that item to a low figure. He had already pointed out that the apparent diminution was more apparent than real, inasmuch as everybody stood on exactly the same footing. The expenses in every branch had been reduced as low at possible, and the losses on the year had been very materially diminished. Another point which he thought gave them more than a gleam of hope was that their attention was devoted to the completion of the copper works at Millwall. Mr. T. Parker had joined the Board, and if he understood the thing thoroughly, and it were properly worked, there was every reason to hope that the deposition of copper would form an important branch of their business. If they should determine to turn the copper into wire, they did not anticipate any difficulty in disposing of all their manufactures. The Kentish Town works would be transferred to Millwall—in fact they hardly existed at present—and a considerable saving would thereby be effected. His Lordship then moved the adoption of the reports and accounts.

Mr. James Pender seconded the motion.

Mr. Dunn observed that the Chairman had said that the loss on the balance-sheet would not affect the holding of the shareholders, but he (the speaker) took it that any loss that was made would certainly affect the value of the shares. He understood that a great deal of the loss arose not during the Company's management, but previous to it. That, he contended, indicated that the property was taken over on too high a valuation, and that it should be written off. He would like to hear what views the Board held with regard to a reduction of the purchase-money.

Sir Henry C. Mance took it that the Chairman implied that the Company was no money out of pocket by writing down the capital. It was what the auditors had advised. The purchase-money was paid for nearly in ordinary shares. The Chairman desired him to state that he thought it rather premature to say that at the present time, but that would, no doubt, be the course to be adopted—that there would be no depreciation in the value of the preference shares.

Mr. Dunn then moved that a committee of shareholders should be appointed to confer with the Board with a view to a re-organisation of the Company.

Mr. Thomas seconded the resolution. He thought the stock had been under-valued. An item of £2,500 written off required explanation, and he wished to know whether the Directors intended to forego their fees for the last nine months, or whether they held that as a liability to be met at some future time.

Sir H. Mance said with regard to the £2,500, the estimated depreciation on plant and machinery, the Directors had left that to the auditors. No doubt the earlier valuation had been based upon what was paid for those goods originally, but he was not connected with the Company at that time. They had, however, written down largely in compliance with the auditors' advice, and they thought that all those things should be placed at their proper value. As regarded fees, as soon as the Directors found that the year was not likely to be so good as they anticipated, they reduced their fees and did not even take them. Personally, he was willing to forego his fees, but the shareholders could not reasonably expect the Directors to do so generally. He did not see that a committee of conference could do the Company any good. They had discussed the matter carefully with the largest shareholders, and had taken steps in consultation with those gentlemen to lessen the costs of management and ensure that the latter would be thoroughly efficient. One step was the strengthening of the Board by the election of Mr. Parker, who would be able to devote some attention to the refining of copper, from which they hoped so much. Under those circumstances he hoped that Mr. Dunn would withdraw his resolution.

Some further discussion ensued, and the resolution not being put, the original motion was carried *nem. con.*

The Earl of Albemarle and Lord Egerton of Tatton were re-elected directors, and the auditors, Messrs. Ward and Wilding, were reappointed, this bringing the meeting to a close.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: John D. Milburn, Esq., chairman; the Hon. C. A. Parsons, managing director; Sir B. C. Browne, Colonel W. M. Angus, John B. Simpson, Esq.

Report of the Directors presented to the shareholders at the sixth ordinary general meeting of the Company at Newcastle on 13th inst.

The Directors have pleasure in reporting that the supply of current continues to give satisfaction to the Company's consumers, and, although the present depression in trade has had the effect of somewhat crippling progress, the prospects of the Company continue satisfactory. The installations connected to the Company's mains during the year are equal to 3,500 10-c.p. lamps, bringing the total up to about 14,500, and 290,469 units of electrical energy have been supplied, as against 206,017 units supplied in 1891. During the past year 3,012 yards of main and branch piping have been laid, together with 6,146 yards of main and branch cable. A tunnel has now been completed from the Company's works to the River Tyne, and condensing plant is being erected to which water will be circulated direct from the river; it is expected that this plant will be in operation next month, and your Directors anticipate a considerable saving of both fuel and water. It is anticipated that there will be a great fall in the price of lamps during this year, which will greatly tend to further the interests of the Company. The gross earnings during the year amount to £2,139. 15s. 1d., and after paying interest, and making provision for reserve fund, and writing off £59. 7s. 7d. from formation expenses, your Directors are able to recommend a dividend at the rate of 3 per cent. for the half year ending December 31 (less income tax), which, together with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year. Sir Benjamin C. Browne retires by rotation, but is eligible, and offers himself for re-election as a director. The auditors, Messrs. Strachan and Co., also offer themselves for re-election.

BALANCE-SHEET, DEC. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Capital—5,000 shares at £10 each	50,000	0	0			
3,535 shares, £8 called up	28,280	0	0			
Add calls paid in advance	200	0	0			
	28,480	0	0			
Less calls unpaid	240	0	0			
				28,240	0	0
Creditors	905	13	11			
Loans	5,000	0	0			
Bankers	4,285	10	8			
				10,191	4	7
Reserve fund for depreciation, etc.				1,400	0	0
Profit and loss account—						
Balance from last year	43	7	3			
Profit for year ending Dec. 31, 1892	1,391	4	9			
	1,434	12	0			
Less interim dividend	563	14	8			
				870	17	4
				£40,702	1	11
Cr.				£	s.	d.
Amount expended to date on buildings and plant, pipes and cables (including cost of laying), meters, transformers, electrical instruments, etc.				36,315	14	4
Office furniture				141	4	2
Stock of stores, etc.				139	15	6
Cost of license, provisional order, etc.				501	16	10
Formation expenses	859	7	7			
Less amount written off	59	7	7			
				800	0	0
Debtors (less reserve for discounts, £200)				2,788	17	0
Cash in hand				14	14	1
				£40,702	1	11

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING DEC. 31, 1892.

Dr.	£	s.	d.
Wages, salaries, rent, rates, taxes, and Directors' fees	1,549	5	9
Stationery and office expenses	132	17	10
Stores, fuel, water, etc.	1,818	8	1
Repairs and renewals	275	13	3
Balance carried down	2,139	15	1
	£5,916	0	0
	£	s.	d.
Interest	239	2	9
Proportion of formation expenses written off	59	7	7
Transferred to reserve fund for depreciation, etc.	450	0	0
Balance carried to balance-sheet	1,391	4	9
	£2,139	15	1
Cr.	£	s.	d.
Electric energy supplied, less discounts	5,627	8	6
Meter and transformer rent	288	11	6
	£5,916	0	0
	£	s.	d.
Balance brought down	2,139	15	1
	£2,139	15	1

The annual meeting of the shareholders of the Newcastle and District Electric Lighting Company, Limited, was held at the offices of Messrs. Leadbitter and Harvey, 57, Westgate-road, Newcastle, on Monday, Mr. John D. Milburn, chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report, said: The leading feature of our present year's work is the payment of a little more dividend. This increase in the earning power is trifling, but it marks progress. A local newspaper stated a month or two ago that the electric lighting companies were not booming. Well, if they were not, it would not be the fault of the companies, which are ready and anxious to meet to the fullest extent whatever public demands there may be. Electric lighting has got over its initial stage, and the directors of the companies are arriving at a fair understanding of its technicalities. To make, however, electric lighting a great success one thing is necessary, and that is cheapness. The following figures will perhaps prove interesting to our newspaper friends, and prove the steady progress we are making: Units sold, 1891, 206,017; in 1892, 290,469; increase, 84,452. Increase of output, 41 per cent.; increase in receipts, 23 per cent.; selling price, 1891, 5·309; selling price, 1892, 4·650; difference per unit, 0·659; cost price, 1891, 3·420; cost price, 1892, 3·113; difference per unit, 0·307. You will see, therefore, that whilst our average price has been gradually reduced, the cost has likewise been reduced, and by the introduction of the shaft and tunnelling to the Tyne and the new condenser, by which superheated steam is used, the cost of fuel is expected to come down to nearly one-half. This is a great economy, but nothing like the saving which will ensue by doubling the production of the current. Cheapness begets demand, and demand begets cheapness of production. In the summer months, when our output is only about 11,000 units per month, the cost of production is about 4½d. per unit. In mid-winter, when the output is 50,000 units, the price per unit comes down to 2d. It is obvious, therefore, that when we shall be able to supply 50,000 units per month, the average cost will be enormously reduced, and we hope at no distant date to be able to produce electric current at a net cost of 1d. to 1½d. It is, however, impossible to attain this end by hoping to sell the current for illuminative purposes alone. We must look to other sources of demand, such as motive power, ventilation, etc. The tramway company has not yet seen its way to adopt electric power, for the sufficient reason that electric trams have not yet been successfully introduced into this country. This, however, will be remedied in time. Light motors have been successfully introduced, and this Company is ready to recommend such motors to supply the necessary current to all who require them. They would prove of great use to all who require light machinery, and who wish to use it occasionally, as is the case with dentists. Electric cooking is now an established fact, and the method can be seen at the Victoria Hotel, where are introduced the best electric cooking appliances in the market. Sixpence per unit electricity, with a properly proportioned installation, is equal to about 5s. per 1,000ft. of gas. The gas company have not much to fear in the way of competition so long as the price of electric lighting stands at 5d. to 6d. What, however, we want to be at is to be able, profitably, to supply electricity for lighting purposes at 3d. per unit, equal to only 2s. 6d. per 1,000ft. of gas. This, as I think I have shown you, can only be done by increased demand for electric current and steady economy in working expenses. There are no by-products in the case of electric current as with gas; therefore, science and ingenuity will have to be called into play to bring about the desired result without doing much harm to the gas company. Recently, this company has had a proposal made to it to cheapen its fuel by the partial use of dust-bin refuse instead of coal. Amongst the component parts of such refuse there is a large amount of ashes and partially-consumed coal, as well as other combustible properties. A company in London has invented machinery for separating this refuse and making a compound of all of the combustible material which then becomes available for steam-raising purposes. It is stated that such fuel is capable of evaporating 3½lb. of water as against 9lb. with coal. Seeing that refuse is now got rid of at a certain actual loss by refuse destructors, etc., this fuel may probably be applied with considerable economy to the raising of steam, and so put to a good useful purpose what hitherto has been consumed for sanitary safety. Your Directors have this matter under consideration, and if upon closer investigation the application of such fuel can be safely and without deleterious result introduced, they will not hesitate to adopt it. Much, of course, will depend upon the terms to be arranged with the Corporation for the removal of the refuse, for your Directors would only adopt the system if they were assured that a real and not a mere nominal value accrued to the Company. In other words, they are not going to attempt any doubtful or quixotic experiment, but intend to sail steadily along, A great stimulus will undoubtedly be given to electric lighting by the termination, in November next, of the patents of the Swan-Edison lamps. At the present time a 16-c.p. lamp costs 3s. 9d. Foreign manufacturers now offer a lamp which appears to fulfil all the conditions of the Swan-Edison article at 10d. each. This will considerably reduce the cost of electric installation, and enable a consumer, at a small cost, to frequently renew his lamps, for it is a fact that after lamps reach a certain age the waste of current is great, and it will pay consumers to take out their lamps at the end of every three or four months and put in new ones rather than run the vitiated article and pay for current which is wasted in the decayed material of the lamp filament and in the struggle to illuminate the blackened glass of the lamps. In reference to the report recently made to the Watch Committee of this city by Mr. Lamb, the inspector of lamps, I have to say on behalf of this Company that we are prepared to prove that the right system has been adopted by this Company for public lighting, and that in no place in England have the lamps given greater satisfaction. Mr. Lamb wishes us to try the Brush system as a pattern to copy. Were we not a very modest Company, we would suggest that the Brush Company should try our system. Our lamps have given satisfaction from the first. They are: those near the central station in Westgate-road, and in the Green Market. Once the light went out on the top of Westgate-hill, but what was the cause? The severe frost froze the mechanism of the lamp, and the Company's officials could no more be blamed for this than the gas company's lamplighter could be blamed for the lights across the Moor frequently going out in wintry weather. We are accustomed to all sorts of tricks in the case of gas both at Newcastle and other places, but the most unvarying exactitude is expected of electric lighting. If there be the slightest slip the occurrence finds its way to the newspapers. We had this year a visit from some members of the Edinburgh Town Council, who wished to find out the best method of electric lighting. We think the result of their journey was to find that whatever place they came to, the system there adopted was the best. In the case of Newcastle, I believe they expressed a surprise that if the Brockie-Pell lamp now used by this Company in connection with the alternating current had done so well, that the Town Council had not gone further with arc lighting. We trust, however that the committee will soon make up its mind to take this electric lighting question (which will cost less than gas in proportion to illuminative power) into consideration.

Sir B. C. Browne seconded the motion, and the report was adopted.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Mr. S. W. Silver (the chairman) presided on Tuesday at the extremely brief twenty-ninth ordinary general meeting of the above Company, held at the Cannon-street Hotel, E.C. The notice convening the assembly having been read by the secretary (Mr. W. J. Tyler), and the report and accounts, published in our last issue, being taken as read,

The **Chairman** stated that although the report was brief, yet he thought they would agree with him that it was satisfactory, as it confirmed the hopes expressed at the last meeting. After carrying to the reserve fund all the premium realised on the new capital issued, together with a portion of the profit made, the year's transactions justified the Directors in recommending the same dividend as hitherto and a bonus, and in placing to the next account a sum as large as that last year. As an instance of the advantageous employment of the additional capital, he mentioned that it had enabled them to lay in from time to time a large stock of raw material on favourable conditions, and by that means they had been able to successfully meet competition and find remunerative employment for their works. During the past year they had made over 3,000 miles of submarine telegraph cable, without, he was glad to say, a fault, and well within the contract period. The same state of affairs prevailed with their French factories, which had been doing good work under the masterful care of their managing director. He had no fear as to the future prospects of the Company. He then moved the adoption of the report and accounts, and the declaration of a dividend of 5 per cent. and a bonus of 2½ per cent., together, 15s., free of income tax, payable on the 15th inst.

Mr. R. Henderson had pleasure in seconding the motion.

There was no discussion on the report and accounts, and the motion was adopted without any dissentient.

Mr. Matthew Gray moved that Mr. Silver and the Hon. Henry Marsham should be re-elected directors. This was seconded by **Mr. Abraham Scott**, and was unanimously carried.

Mr. Martindale proposed, and **Mr. Cochran** seconded, that Mr. Clarke should be appointed auditor instead of Mr. J. Weise, who had resigned. This was adopted, and the meeting came to a close with a vote of thanks to and confidence in the Board.

COMPANIES' REPORTS.

WESTMINSTER ELECTRIC SUPPLY CORPORATION.

Directors: The Right Hon. Lord Suffield, K.C.B., Edmund Boulnois, Esq., M.P., W. Hayes Fisher, Esq., M.P., Sir Douglas Galton, K.C.B., F.R.S., J. Browne Martin, Esq, James Heslop Powell, Esq., R. W. Wallace, Esq. General manager: Captain Edmund I. Bax. Engineer-in-chief: Prof. Alex. B. W. Kennedy, F.R.S., M.Inst.C.E. Secretary: Frank Iago, Esq.

Report of the Directors to be presented to the shareholders at the ordinary general meeting to be held at the Corporation's Offices, Eccleston-place, S.W., on Wednesday, February 22, 1893, at 11 a.m.

The Board of Directors, in presenting their report and accounts for the year 1892, are gratified in being able to state that the business of the Corporation continues to make steady and satisfactory progress. After very careful consideration, the Directors decided from July 1, 1892, to reduce the price of current from 8d. to 7d. per unit. The policy of reducing the standard charge which this Corporation initiated, has been fully justified by the increased consumption of current. On December 31, 1891, electric energy was being supplied from the Corporation's mains to the equivalent of 62 820 lamps of 8 c.p., and the supply increased to 98,686 on December 31, 1892. At the present time there are on circuit the equivalent of 102,743 lamps of 8 c.p., and applications have been received for a further 8,229. The total length of roadway along which mains have been laid exceeds 33 miles, making about 130 miles of ways, into which upwards of 97 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year. Since the last meeting of shareholders the building at Davies-street has been completed, the frontage having been finished as shops and chambers. In September last the chief office was transferred to Eccleston-place on the completion of the buildings there. Great convenience has been experienced by the concentration of the general staff under one roof. As promised at the last meeting, the Directors offered £40,600 in £100 4½ per cent. mortgage debentures to the shareholders, by whom the issue was immediately taken up. The Directors were pleased to be able to pay a first dividend at the rate of 3 per cent. for the half-year ending 30th June last. The accounts now show a balance of £7,324. 8s. 9d. to the credit of net revenue, and they recommend the payment of a dividend at the rate of 4 per cent. for the past half-year, carrying forward a balance of £1,324. 8s. 9d. In accordance with the articles of association, two of the Directors, Messrs. J. Browne Martin and R. W. Wallace, retire, but being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, but, being eligible, offer themselves for re-election.

The total capital of this Company is £370,000 as follows: Share capital, £299,500; founders' shares, £500; mortgage debentures, £70,000.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
A.—To Generation of Electricity.						
Coal, carriage, and unloading, etc.	5,313	8	1			
Oil, waste, water, and engine-room stores	1,281	18	0			
Proportion of salaries of engineers and officers	1,461	10	0			
Wages, etc., at generating stations...	4,315	0	0			
Repairs and maintenance: buildings, £51. 4s. 8d.; plant, £1,198. 18s. 4d...	1,250	3	0			
				13,621	19	1
B.—To Distribution of Electricity.						
Repairs, maintenance, and renewal of mains and meters	351	1	0			
Proportion of salaries of officers..	156	0	0			
Wages and gratuities, etc.	824	16	6			
				1,331	17	6
C.—To Rents, Rates, and Taxes.						
Rents	1,331	13	10			
Rates and taxes	1,032	15	4			
				2,364	9	2
D.—To Management Expenses.						
Directors' fees	800	0	0			
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	2,020	11	5			
Stationery and printing	281	18	1			
General charges and office expenses ...	293	0	2			
Auditors of Company	52	10	0			
Wages of meter readers, inspectors, etc.	527	11	6			
				3,975	11	2
E.—To Law and Parliamentary Charges.						
Law charges				355	2	5
F.—To Depreciation.						
Sinking fund on buildings and leases	400	0	0			
Depreciation on plant and machinery	2,500	0	0			
				2,900	0	0
G.—To Special Charges.						
Insurance	219	13	0			
Board of Trade audit (two years)	65	12	6			
				285	5	6
Total expenditure				24,834	4	10
Balance to net revenue				11,608	10	2
				£36,442	15	0

Cr.	£	s.	d.
Sale of current by meter, etc.	33,499	8	6
Sale under contract	1,455	4	0
	34,954	12	6
Rental of meters on consumers' premises	1,431	5	0
Transfer fees	56	17	6
	£36,442	15	0

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Capital account				370,000	0	0
Sundry creditors				2,963	0	0
Unclaimed dividends				24	17	1
Debenture interest accrued				716	12	6
Depreciation account				3,530	0	0
Sinking fund account				812	0	0
Net revenue account	£11,816	2	4			
Less half-year's dividend paid to 30th June, 1892	4,491	13	7			
				7,324	8	9
				£385,370	18	4

Cr.	£	s.	d.	£	s.	d.
Capital account				351,196	19	10
Stores in hand				607	5	3
Sundry debtors				13,405	11	4
Cash on deposit				6,000	0	0
Cash at bankers, Messrs. Barclay, Ransom and Co.				3,520	13	9
Deposits with vestries, etc.				294	16	7
Preliminary expenses and suspense account	9,450	2	7			
Less amount written off for 1892	1,000	0	0			
				8,450	2	7
Patents and law charges account	2,105	9	0			
Less amount written off for 1892	210	0	0			
				1,895	9	0
				£385,370	18	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1892.

Board of Trade units generated		1,477,131
Quantity utilised:		
Sold to consumers	1,217,871	1,263,566
Used for lighting works, meter testing, etc.	45,695	
Quantity expended in distribution:		
In batteries	20,810	166,875
In feeders	146,065	
Total quantity accounted for		1,430,441
Quantity unaccounted for		46,690
Number of 8-c.p. lamps on circuit, Dec. 31, 1892		98,686

NEW COMPANIES REGISTERED.

Wallis and Steevens, Limited.—Registered by Coldicott and Bowden, 22, Basinghall-street, E.C., with a capital of £60,000, divided into 440 preference shares of £100 each, and 1,600 ordinary shares of £10 each. Object: to acquire as a going concern the business of engineers carried on under the style of Wallis and Steevens, at the North Hants Ironworks, Basingstoke, and, with a view thereto, to adopt and carry into effect an agreement expressed to be made between A. Wallis, A. H Wallis, J. E. Wallis, and W. A. Wallis of the one part, and this Company of the other part; generally, to carry on the businesses of mechanical, consulting, and electrical engineers in all their respective branches. The first signatories are:

	Shares.
A. Wallis, Coombehurst, Basingstoke	1
A. H. Wallis, Coombehurst, Basingstoke	1
J. E. Wallis, Erdesley, Basingstoke	1
W. A. Wallis, Coombehurst, Basingstoke	1
F. A. Wallis, 27, Wote-street, Basingstoke	1
C. Wallis, Coombehurst, Basingstoke	1
J. Bick, Station-hill, Basingstoke	1

There shall not be less than two nor more than five directors. The first are A. Wallis, A. H. Wallis, J. E. Wallis, and W. A. Wallis. Qualification, £100. Remuneration to be fixed by the Company in general meeting.

BUSINESS NOTES.

Luton.—The telephone at the Luton Workhouse is often out of repair, and Mr. Garrett, of Dunstable, has been called in to remedy this.

Farnham.—The authorities of Farnham do not consider that telephones to the fire station would be of sufficient utility to pay £10 for.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazirian Company, were £3,616.

Fleetwood.—The chairman of the Fleetwood Improvement Commissioners, at the last meeting, alluded feelingly to the death of Mr. Gordon, who had recently furnished them with a scheme for electric lighting.

Redditch.—At the meeting last week of the Redditch Local Board, Mr. T. Evans gave notice that at the next meeting he should propose that the Board apply for a provisional order for lighting the town by electricity.

Liverpool Railway Bell Signals.—The contract for the station-to-station electric bell signals and the electric bell communication in the cars on the Liverpool Overhead Railway was carried out by Messrs. Mannsell, Mercier, and Co., 5, Deansgate, Manchester.

Westminster Electric Supply Corporation.—In their report the Board propose a further dividend at the rate of 4 per cent. per annum, making, with the interim dividend already paid, a total of 3½ per cent. for the year ended December last, carrying over £1,324

Eastbourne.—Mr. F. G. Clark, chartered accountant, of 56, Ship-street, Brighton, was appointed auditor of the accounts of the Eastbourne Electric Light Company, Limited, for the period ended December 31, 1891, at a remuneration of five guineas and travelling expenses.

City and South London Railway Company.—The receipts for the week ending February 12 were £952 against £881 for the corresponding period of last year, or an increase of £71. The total receipts for 1893 show an increase of £829 over those for the corresponding period of 1892.

Cheltenham.—At the meeting of the Cheltenham Town Council Mr. Norman mentioned that the Electric Light Committee had, in accordance with the wish of the Council, invited Mr. Preece, engineer to the General Post Office, to draw up a report on the electric lighting question.

Commissioners of Sewers.—At the last meeting of this body, Mr. Pannell said, as the principle of electric lighting throughout the City had been recognised, there was, he thought, no further need of his presence on the Streets Committee, and he would therefore withdraw his name. Mr. Walter was elected to fill the vacancy.

Edinburgh.—As one of the first questions to be decided is the system, high or low tension, and this depends much on the customers in a certain district, the Edinburgh Town Council think it advisable to send out circulars to find out the number of persons desirous of the light. Their electrical engineers are to be first consulted.

Lynton Railway.—The private Bill for this railway is suspended. Amongst other provisions, running powers were sought over the London and South-Western Railway Company's system into Barnstaple Station, and the name of the company was proposed to have been changed to the "Barnstaple and Electric Tramroad Company."

Electric Traction in France.—The new Compagnie Française Thomson-Houston, just formed, will commence by laying two electric tramways, one in one of the French seaports, and the other at Lyons. In the latter town a certain number of lines are to be first equipped with the intention eventually to convert the whole system to electric traction.

Liverpool Railway.—It is officially announced that the Liverpool Overhead Railway will be opened for public traffic before the end of the present month. The various contractors have been finishing their work during the week which has elapsed since the formal opening by Lord Salisbury, and a series of experimental trains will now be run pending the actual opening.

Electricity Supply Corporation, Limited.—The report for 1892 states that out of the available profits the directors, after providing for the interim dividend up to June 30, and writing off the debit balance brought forward for 1891, propose a dividend for the year up to December 31 at the rate of 5 per cent. on the capital from time to time paid up, and to carry forward the balance.

Farmhouse-Lighting.—During the past three weeks, the farm of Burnside, Longmanhill, in the parish of Gamrie, tenanted by Mr. Reid, has been brilliantly illuminated by the electric light. A fall of water is used to give the motive power. Mr. Reid has, it is interesting to remark, done the whole of the work himself, getting his main ideas of mechanical construction from one of Cassell's publications.

Llandudno.—The Llandudno Improvement Commissioners have instructed their engineer, Mr. E. P. Stephenson, A.M.I.C.E., to prepare a report upon the advisability, means, and expense of lighting the town by electricity. Llandudno is one of the finest and healthiest watering places on the West coast, and its visitors will receive with approval the information that electric light is likely to be introduced.

Burnley.—At a meeting of the Burnley Gas and Electric Lighting Committee last week, the tender of Callender's Bitumen Telegraph Company for electrical cables was accepted at the sum of £3,605. The committee also accepted the tender of Mr. James Procter for supplying mechanical stokers to be attached to the boilers at the electric lighting station at the sum of £65 per boiler, less 7½ per cent. discount.

Henley.—Certainly Henley in summer is to be preferred to Henley in winter, but there is no denying the fact that in winter electric light would glorify the streets of this riverside town. So think the Town Council, and they have directed the clerk to obtain particulars as to the cost of a provisional order. Here is scope for the usual machinery to get to work—consulting engineer, parliamentary agents, and eventually contractors; and Henley is a pleasant enough place to run down to for a visit.

Bromley.—The Bromley Local Board meeting last week received a report from the Electric Lighting Committee, stating that, at a meeting of the Electric Lighting Committee held on January 31, the committee had under consideration the replies received to the circulars addressed to the frontagers on the proposed circuit to be laid down under the provisional order; and the further consideration thereof was adjourned until the Local Government Board inquiry has been held in reference to the acquisition of the proposed site in the Station-road for a central station.

Glasgow.—Councillor Burt stated, at the last meeting of the Glasgow Town Council, in regard to the electric lighting operations in the city, that, as far as the incandescent lighting was concerned, they were now in a position to supply any number of regular customers; and that, as regarded the street-lighting, they hoped to be able to have the lamps lighted within a fortnight in Sauchiehall-street, Renfield-street, Union-street, Jamaica-street, and George-square. Owing to the operations of the Central Railway it would be some time before Argyle-street could be lighted.

Osborne.—The entire electric light installation at Osborne was carried out by Mr. William Massey, of Twyford, recently appointed electrical lighting engineer to the Queen, and though the arrangement is at present confined to the splendid Indian Room and to several of the corridors, it will certainly be extended. A 22-h.p. engine is situated in a detached outbuilding, surrounded by shrubs. An accumulator-house is adjoining, E.P.S. cells being used. The mains are carried along the subterranean corridors, which traverse the palace from end to end. The installation was satisfactorily fitted in three weeks' time.

Walsall.—At the Walsall Town Council quarterly meeting last week, on the recommendation of the General Purposes Committee, Mr. F. Brown was appointed consulting electrical engineer to the Corporation, and to superintend the carrying out of the electric-lighting scheme for the borough, and the construction of the necessary works in connection therewith, at a fee of 350 guineas, such fee to include his services for a period of three months after the works are completed and the supply of electricity to consumers is commenced. Alderman Brownhill said the expenditure upon the scheme would be from £15,000 to £20,000.

Llangollen.—At the last meeting of the Llangollen Local Authority, Mr. J. P. Davies observed that he could not help feeling that they in Llangollen were considerably behind the time in regard to the lighting of the town. In Dolgelly, he understood, they had the electric light at a cost of £80 a year, while the public lighting in Llangollen cost them £140 a year. He felt that with the facilities they had they ought to go in for the more modern and better system of lighting by electricity. He moved that the Board should form itself into a committee to consider the question of the lighting of the town of Llangollen. This was agreed to.

Reduction of Current Price.—The Westminster Electric Supply Corporation have given notice that from March 31 next, the standard charge for electric energy will be reduced to 6d. per B.T.U., with a sliding scale of rebate to clubs and other large consumers. For current supply for lifts and other motor power the charge is 5d. per unit.—The London Electric Supply Corporation also announce that from the 1st April next their standard charge for electrical energy will be 6d. per Board of Trade unit. All customers will also be entitled to the benefit of a sliding scale extending from the standard rate to 5d. per unit, based on their *consumption of energy.*

Bath.—At the Bath Town Council meeting, the committee reported that the experiment previously referred to, by which it was hoped to detect the failure of the electric light, was unsuccessful, and that the electric light company proposed to send out workmen at proper intervals each night to ascertain and report what lights were extinguished, in order that they might be relighted without delay. The committee recommended, under these circumstances, that the 5s. penalty under contract be enforced against the company from and after February 1, and that the balance of account delivered by the company be paid, subject to the usual deductions. These recommendations were adopted.

Bowness.—At the last meeting of the Bowness Local Board a letter was read from the Bowness-on-Windermere Association, stating that at a meeting recently held a resolution was passed to the effect, "That the Local Board be requested to reconsider the question of electric lighting in the district with a view to taking over the producing of the light into their own hands." The clerk said they should bear in mind there was a clause in the agreement they had come to with Mr. Fowkes by which, if the Board thought it desirable, they could take over the works at the end of two years' working, without prejudice to anyone. It was agreed to send a copy of the clause to the association, and the matter was dropped.

Windermere.—At the meeting of the Windermere Local Board on the 8th inst., the chairman stated he had that morning an interview with Mr. Cloudsdale and Mr. Gatey, chairman and clerk of the Bowness Local Board, respecting the applications which had been made by Mr. Fowkes for permission to put down his electric cables. The only difficulty which appeared to have been standing in the way was about the agreement which was made between Mr. Fowkes and the Bowness Local Board. He now had that agreement, and he thought all cause for objection to the laying of the electric cable would be removed. Mr. Fowkes was by this time in attendance, and after the reading of the agreement the matter was considered in committee.

Bristol.—The Electrical Committee of the Bristol Town Council reported at the meeting last week that they had advertised for tenders for the supply, delivery, and erection of underground feeders, mains, junction and house boxes, arc lamps, lampposts, brackets, and suspension gear. They had carefully considered the tenders received, and resolved to recommend the Council to accept that of Messrs. Siemens Brothers and Co., Limited, at the sum of £16,658 10s., and to enter into contract with them accordingly. So far, the committee have not settled the price at which they will be able to supply the light for private consumption, but they are considering this question, and will shortly issue a circular on the point, giving comparison with gas and other information.

Blackpool.—At the quarterly meeting of the Blackpool Town Council last week, the Electric Lighting and Tramways Committee submitted the following minutes, which were accepted: "January 27th.—Resolved that the tender of Messrs. S. and J. Whitehead for the stonework (labour and materials) and brickwork (labour only), of Mr. Thomas Hartley for the joiner's work (labour and materials), of Messrs. John Kay and Sons for the slater's work (labour and materials), and of Messrs. Worthington and Sons for the plumber, painter, and glazier's work required for the new electric light station be accepted. That the tender of Messrs. James Allen, sen., and Son for ornamental cast-iron electric lampposts for public electric lighting on the promenade be accepted, subject to a sample lamppost being approved."

Manchester.—The Gas Committee of the Manchester Corporation announce that they are prepared to receive applications for the supply of electricity to premises situated in the following streets and other main streets within and adjacent to the area specified below—viz.: Deansgate (from Peter-street to St. Mary's-gate), St. Mary's-gate, St. Ann-street, Market-street, Piccadilly, Portland-street, Mosley-street, York-street, Spring-gardens, King-street, Princess-street (from Portland-street to Albert-square), John Dalton-street, Cross-street, Albert-square, South-street, Oxford-street (from Portland-street to Peter-street), Peter-street. It is likely that requests for supply will be numerous, therefore, as far as practicable, the various premises will be connected up to the Corporation electrical conductors in the order of application.

Dewsbury.—At the monthly meeting of the Dewsbury Town Council the report of the General Purposes Committee was read as follows: "The committee had an interview with Mr. W. H. Preece, and discussed with him various points in his report and specification with regard to electric lighting. It was agreed that the report and specification be adopted, but reserving the question of the site of the central station for subsequent consideration; also that the town clerk ask for tenders. A letter was read from Mr. B. Turner, of Batley, secretary to the Heavy Woollen Trades and Labour Council, asking the Council to adopt a certain provision." The Mayor moved the confirmation of these minutes, and it was seconded. Councillor Birkhead moved an amendment with reference to rates of wages, but this was negatived. An amendment by Alderman Fox to refer the matter back for further consideration was, however, carried.

Weston-super-Mare.—At the monthly meeting the Town Commissioners of Weston-super-Mare had before them the report of the Inspection Committee, who reported that a letter was received from the secretary of the British Electrical Engineering Company, Limited, stating that his directors had been given to understand that the Board were considering what steps should be taken with their electric lighting provisional order, and he was instructed to say that in the event of the Board being prepared to receive a proposal from them for the transfer of their provisional order to a local company to be formed by them, they were prepared to place a proposal before the Board. The committee recommended that the clerk be instructed to reply that the Board were open to consider a proposal, but that any proposition for payment of goodwill at a valuation on the expiration of the term fixed would not be acceptable.

A Station Assistant Killed.—An inquest was held at the Town Hall, Brighton, last week with regard to the death of George Gifford, which occurred at the Brighton and Hove Electric Light Company's Gloucester-road works on Sunday night. It appeared that the deceased, a married man about 28 years of age, went to help the electrician in charge to pull out one of the switch plugs. As he was unable to do so with the insulated handle he inadvertently seized hold of the base of the switch plug with both hands, as a result of which the current passed through his body, and he was killed instantaneously. The jury returned a verdict of "Accidental death," adding as a rider that the instruments ought to be better protected. With this opinion we entirely agree. It has been said that accidents of this kind with experienced men will not occur. A moment's inadvertence is, however, sufficient to cause a fatal shock. It ought to be practically impossible to make connection without wilful negligence.

Electrical Registers.—Mr. W. A. M. Brown, of the Green Dragon Hotel, Leeds, has invented an ingenious electric till calculator, which possesses many advantages over the machine which is in common use in hotel bars and shops, for registering the amount of individual purchases. Whenever a purchase is made, the attendant records the fact by pressing buttons on a disc placed on the counter, and this communicates with an indicator, which may be placed in any part of the premises—in the manager's private office or any other convenient spot. The chief merit of the invention is the ingenious arrangement by which the takings of the day are added up automatically and exhibited on the indicator, so that at any moment the exact amount of cash received is shown. Mr. Brown has also invented a ticket register, intended for use in a theatre or other place of amusement, which will shortly be fitted up at the Grand Theatre, Leeds. In this case, also, a dial worked by electricity records the amount of tickets issued.

The Madras Electric Tramway.—At an influential meeting of the leading citizens of Madras, with reference to the Madras electric tramway, at which Mr. Digby, the chairman, and Mr. Falconer, the engineer, explained in full the future prospects of the company, about 4,000 shares were taken up on the spot. Mr. H. Falconer was for some years the chief engineer of the Bombay Tramway Company, having had to do with the construction and extension of that tramway, and has a thorough knowledge of track construction as well as of electric cars. About 6,000 shares are yet wanting to make up three-fourths of the estimated outlay, which the company must have actually deposited in the bank before work is begun. Mr. Faulkner is visiting Calcutta with the object of ascertaining the practicability of utilising the heat of destructors for boiler power. Mr. B. R. Barrington has been burning the refuse at Calcutta in his incinerator. The demand for refuse destructors is increasing in India, and if Mr. Faulkner's idea can be carried out the Madras electric tramway will inaugurate a new departure in two ways at once.

Portrush.—At the monthly meeting of the Portrush Town Commissioners the question of the future lighting of the town was raised. The chairman said that as the Commissioners were not the urban sanitary authority for Portrush, they were precluded from erecting electric lighting plant for themselves, but they could enter into a contract with some of the lighting companies. The clerk had been in communication with the lighting boards in Carlow, Bray, and Larne, and had received most favourable replies as to the acceptability and advantages of the light. He also had received proposals and prospectuses from various companies who were desirous of treating with the Commissioners in the matter. He said it would be for the Board to consider whether they should apply for powers to become the urban sanitary authority, when they could erect lighting plant for themselves, or to contract with some electric lighting company for the lighting of the town. Captain Watt proposed that the Board should advertise for tenders for the lighting of the town by electricity. Captain Robinson seconded the motion, which was agreed to.

Coast Communication.—An application having been received by the Torquay Town Council at the last meeting from the postal authorities for sanction to erect telegraph poles and wires between the post office and coastguard station, in connection with the system of coast communication initiated with the view of saving life at sea, Mr. Appleton expressed the hope that ornamental poles would be used. Mr. Harrison objected to the poles altogether. The authorities had plenty of money and should put the poles underground. He moved that the matter be referred to the Roads Committee. Mr. Butland seconded, remarking that he thought the committee should consider the whole question of telegraph and telephone poles. Mr. Evans thought that they ought not to put any difficulty in the way of providing coast communication, and moved as an amendment that the request be granted. Mr. Mortimer seconded. The Mayor thought that as the object was to save life the Council ought not to put any obstacle in the way. Mr. Harrison disclaimed any intention of obstructing such an effort. The amendment was carried.

Lambeth.—The Electric Lighting Committee of the Lambeth Vestry have consulted Mr. W. H. Preece, the chief consulting engineer to the Post Office authorities, as to the best mode of carrying out the electric lighting order granted by the Board of Trade to the Vestry last year, and subsequently confirmed by Parliament. In his report to the committee, Mr. Preece remarks that it has been the fashion to regard the electric light as the lamp of luxury, and strange views are frequently expressed as to its costliness and as to its being within the reach only of the rich. The experience at Newcastle, where gas is only 1s. 10d. per 1,000 cubic feet, and at Bradford, shows that it is now within the grasp of the poor man. The average cost per electric lamp per annum at the former place was last year 6s. 3d., and at the latter place 9s. 7d. Electricity can now be produced cheaper than gas. He is now engaged, Mr. Preece goes on to remark, in determining the best and cheapest mode of fitting up small tenements, so as to bring the light within the reach of the poor. He estimates that the total capital required to light the whole parish would eventually reach £300,000, but adds that it will take some years and much prosperity to attain that result. To comply with the requirements of the provisional order, and to make a good start, will not require more than £75,000, for which sum sufficient plant can be obtained to supply energy to 20,000 lamps alight at one time, which would mean 40,000 lamps fixed.

Football by Electric Light.—For the first time in the history of sport in Hull, a football match has been played on the enclosure of the Hull Football Club, on the Holderness-road, by the light electric. Any stranger in the town who chanced to be on this road on Wednesday night last week, between 6 and 7 o'clock, would have easily seen that something out of the common was happening: cabs and waggonettes by the dozen were carrying full freights of passengers to the scene of the encounter, whilst hundreds, and even thousands, of eager people journeyed on foot. The crowd assumed the dimensions and boisterous jollity of a Bank Holiday gathering, and many ladies were present. By 7 a crowd of some 8,000 persons had congregated. Eight arc lamps surrounded the field, supplied by Mr. G. B. Blanchered, of Whitefriargate, Hull. Three were placed on each side and one at each end. The lighting was good, but still more power should be used for a brilliant result. The affair has been a splendid advertisement for electric light, and although it is difficult to make the experiment entirely successful, it is one of the best ways of getting the public in some towns convinced of the efficacy of the electric light. It may be mentioned for those Southerners who guide the destinies of electric light, that for the bulk of Northerners all considerations seem laid aside once a week or more for football. The whole place goes mad for a time, and nothing but football in some towns is talked of on Saturdays. A display of electric light applied to their favourite sport may therefore prove to be the turning point in its favour, if well carried out, when other means fail. Exhibitions of cooking and lighting may serve, and Hull has had both, so that the success of electric light in that town seems assured.

Coventry Tramways.—At a meeting of the General Works Committee of the City Council, held on Tuesday last week, Alderman Marriott presiding, the town clerk submitted a draft agreement between the Corporation and Mr. W. S. Graff Baker, which Mr. Baker had submitted as a basis for consideration. The agreement contains five clauses. In it Mr. Baker agrees to equip the tramways upon the Thomson-Houston system for a reasonable and efficient service, and to keep it in thorough and efficient repair during the continuance of the agreement, and at the expiration of each completed period of five years the Corporation may call in the services of an arbitrator to be appointed by the Board of Trade, or the president of the Institute of Civil Engineers, to determine if the provisions of the agreement as to service, maintenance, and repair of the electrical equipment have been duly complied with. The decision of the arbitrator is to be final and binding on both parties, and in the event of the arbitrator deciding that the provisions of the agreement have not been complied with, he is to determine in what manner such default shall be made good, and within what period of time, under a penalty of five pounds for every day such period may be exceeded. The standards used for the support of any wires are to be of a design approved by the engineers for the time being of the Corporation, and the Corporation shall, on giving 14 days' notice, have the right to use the standards for the support of electric or gas lamps, the property of the Corporation. The Corporation shall not exercise until after the expiration of a period of 21 years from the date of the agreement the powers of compulsory purchase of the tramways, or any part, which are or shall be conferred upon the Corporation by Section 43, or otherwise, of the Tramways Act, 1870, or by any statutory modification, or by the Acts of Parliament authorising the construction of the tramways, anything in the Acts, or any of them notwithstanding. The provisions of the Tramway Act, 1870, and of the Coventry and District Tramway Company's subsequent Acts are to be deemed as incorporated in the present agreement. If the line has not been equipped so that it can be opened for public traffic upon the electric system before September 30th, 1893, the Corporation may require the tramways to be so equipped within three months from the date of the notice. If, at the end of three months the line has not been so equipped, the agreement shall become void at the expiration of seven days from the giving of a notice in writing by either party to the other of them determining the agreement. Further consideration of the matter was adjourned in order that each member of the committee might be supplied with a copy of the draft agreement.

Breaking Streets at Windsor.—An important paper was presented at the monthly meeting of the Windsor Town Council last week. The Streets Committee presented a report in which was the following item: "The application by the Windsor and Eton Electric Lighting Company for permission to break open Peascod-street, referred to your committee, has been considered by them, and they beg to report that they had been advised that the Council had no power to give permission to break open the streets. The memorandum upon the subject which has been submitted to yo committee accompanies this report." The full text of clerk's opinion, to which reference is made above, is entitled: "Memorandum as to Streets and Highways.—By the common law of the land, the public at large, not the inhabitants of any particular district only, but the whole community at large, have the right to the free and unrestricted use of the public streets and highways for passing over and along and to and fro at all times without any obstruction whatever. No person, company, or other authority whatever can legally break up the surface of the highway, or do anything whatsoever which would interfere with or obstruct the free and safe passage of the public over and along the highway, unless they are authorised so to do by Act of Parliament. In other words, unless the sanction of the community at large has been given through its representative in Parliament. Neither the surveyors of the highways nor any other local authority are empowered to give any permission or sanction to anyone to break open the public highway, or do any act or thing whatever which may obstruct or interfere with the free passage of the public highway; and all persons breaking open the highway or doing any such act or thing without the authority of Parliament, are liable to be indicted at the quarter sessions by or at the instance of any person, for committing a public nuisance. The section of the Public Health Act, 1875, imposing a penalty for displacing or taking up the pavement, etc., in any street, without the consent of the urban sanitary authority, is an additional remedy which does not prejudice or interfere with the other remedies by indictment or injunction; nor does such section authorise the urban sanitary authority to give permission for breaking up or obstructing the public highways. The breaking open of the streets or highways is an annoyance amounting to a common nuisance, causing great inconvenience to residents and passengers, but it is to the common interest of all to submit to such annoyance and inconvenience when done for public purposes and under proper restrictions. Accordingly Parliament has, for certain public purposes, such as the construction of railways and tramways, the laying down of water and gas pipes, the construction of sewers and drains, and other similar public works, given powers to public bodies and companies to break open streets and highways; but these powers always have conditions and restrictions attached to them, which must be fulfilled before the powers given can be legally put into operation; furthermore, it is usually provided by the special statute conferring such powers, or by some general statute incorporated therewith, that no street or highway shall be opened or broken up except under the superintendence of the persons—*id est*, in nearly all cases the surveyors of the highway—having control and management thereof, or of their officer, and according to such plan and in such manner as shall be approved of; so that although, on the one hand, the public are bound to submit to the annoyance and inconvenience of having the public ways broken up, they have, on the other hand, the protection that those who break up the highway must make the injury cease as soon as possible, and are liable to very heavy penalties and fines if they do not do so. It is clear that no authority less than Parliament itself can give any power or permission to break open the public highway, and by doing so they might render themselves liable to legal proceedings jointly with the persons actually breaking open the highway. Breaking open the streets to lay down sewers or drains is done under powers given by the Public Health Acts. Section 149 of the Public Health Act, 1875, vests the public streets and highways in the urban sanitary authority, but it has been decided by the Law Courts that this vesting only gives the sanitary authority a qualified property in the street. It concerns only the property in the surface and in such part of the soil as is or can be used for the ordinary purposes of a street, and not more than such proprietary right or interest as is necessary to protect the street and the traffic from obstruction, interruption, or danger. The absolute ownership of the soil still remains in the adjoining landowners so long as they do not exercise their rights of ownership to obstruct or interfere with the public right of way and passage."

Brighton.—The Brighton Corporation Electricity Works, of which Mr. Arthur Wright is manager, have issued a handsome and exceedingly useful pamphlet on the introduction of electric light to intending customers. The probable cost for lamps constantly used is given at ¼d. an hour, with reduction if used for more than two hours. The reason consumers' bills have been more than gas is that they have had more candle-power. For motive power used eight hours a day the electricity would cost about 4d. per horse-power hour. The cost of wiring varies from 20s. to 30s. a lamp. Consumers are recommended to insist on the following conditions when having their premises fitted up: "(1) The work to be carried out to the satisfaction of the manager and in accordance with fire office rules; (2) that not more than 1 per cent. loss of pressure occur in any of the wires when all lamps are lighted; (3) that two large porcelain switches be provided for disconnecting the interior wires from the mains; (4) that lamps of specified pressure be supplied and guaranteed for a time. The importance of having the wiring carefully done cannot be too strongly insisted upon, as on this largely depends the duration or life of the lamps; and it may be taken as generally true that when frequent leakage or rapid blackening of lamps occurs, the cause is either insufficient or bad wiring, or that the lamps are insulated to the standard pressure of the installation." The following are given as "hints as to the economical wiring and use of the electric light: It is, in the end, highly economical to have numerous switches, so as to be able to turn off single lights or batches of lights when they are not required. When the greatest economy in first cost and maintenance is essential, it is well to use pendant opal shade fittings, and to have the lamps unobscured and *hung up as high as possible.* When more artistic fittings and effects are desired the lamp bulbs should be slightly frosted, or surrounded by cut-glass shades or globes. All lamps should hang vertically, as they last longer than when placed horizontally, and all should be easily accessible for purposes of cleaning and renewing. As soon as the lamps look black they should be replaced by newer ones, as it is extremely bad economy to waste electricity in order to save worn-out lamps, and it must be remembered that a black lamp bulb wastes a very large percentage of the light produced inside it; lamps, which through age and use give on trial only half the light obtainable from a new one, should be replaced at once. As the lamps are gradually renewed the older ones should be placed nearer the source of supply, and the newer ones placed farther off; if this be done, the lamps will last much longer and not blacken so soon. In private rooms and passages switches should always be placed near the door. Passages, basements, and storerooms can often be sufficiently lighted by 8-c.p. lamps. As lamps of greater than 32 c.p. very rapidly blacken, it is more economical to use a greater number of smaller candle-power lamps. In case the lighting becomes unsatisfactory, the cause will most likely be found in the fittings or lamps; it is therefore advisable to first consult the firm who put in the wiring, and if not then remedied, to inform the Corporation manager at the North-road works. Never use lamps made for a lower pressure than the Corporation standard—namely, 115 volts—as although they would give at first a much better light, in a very short time rapid blackening or wearing out would take place." As regards price: "From the 1st January, 1893, only half-price will be charged for the electricity consumed during each half-year, beyond that necessary for an average daily use for two hours of each 8-c.p. lamp demanded. Consequently, the average price for electricity during any year will depend on the number of hours the lamps are used per day, and will rapidly diminish as the average time exceeds two hours, as shown by the following table:

Average number of hours.	Average price.
2 hours or any less	7d. per unit.
$2\frac{1}{2}$ hours	$6\frac{3}{16}$d. ,,
3 ,,	$5\frac{4}{5}$d. ,,
$3\frac{1}{2}$,,	$5\frac{1}{2}$d. ,,
4 ,,	$5\frac{1}{4}$d. ,,
$4\frac{1}{2}$,,	$5\frac{1}{16}$d. ,,
5 ,,	$4\frac{9}{16}$d. ,,

A recording instrument will be placed by the Corporation on every consumer's premises, the readings of which, averaged in the three darkest months of each half-year, will indicate the number of 8-c.p. lamps demanded, also the number of units to be consumed in that half-year before the half-price is charged. Consumers (whether large or small) who use the light from dusk until after 8 in evening, or during the day, are those who will receive the largest benefit by the reduced charge."

Maidstone.—The following is the report by Mr. W. C. C. Hawtayne, consulting electrical engineer, on a scheme for the establishment of an electricity supply station at Maidstone, presented to the Electric Lighting Committee of the Local Board of the borough of Maidstone:

In accordance with the instructions conveyed to me in your letter of the 29th September last, I have gone carefully into the question of the establishment of an electricity supply station in the borough of Maidstone, and looking at the size and importance of the borough and its rapid advancement, and comparing it with other towns of the same size and even with smaller towns, where the supply of electricity has become a great and increasing industry—such as Chelmsford, population 11,000, where the electric light company formed by Messrs. Crompton and Co. already supply current for 1,600 8-c.p. lamps, besides having for three years past contracted for the whole of the street-lighting (the town being lit by about 20 arc lamps and about 300 incandescent lamps of 32 c.p.)—I am convinced that there is ample field at Maidstone for an undertaking of a similar nature. I am also of opinion that the proper persons to undertake the supply are the local authorities to whom special facilities are offered by the Local Government Board and the Board of Trade, and as a great many of the townspeople are anxious for the introduction of the new illuminant, it is very certain that if the Corporation do not themselves undertake the supply one of the numerous electric contracting companies will step in and reap a handsome profit, which might well go towards the improvement of the town-lighting or the reduction of the present rates; and, further, in that the Board of Trade have steadily refused to grant a license to more than one company in a district, the supply of electricity is bound to become a monopoly, and it is far more to the interest of a town that such a monopoly should be in the hands of the townspeople themselves and not in the hands of a company, whose chief object must be to benefit its own shareholders, and who will look on the declaration of a good dividend as of far more importance than the question of satisfying the wishes of the community. It was at first proposed that arrangements should be made for lighting High-street, Earl-street, Faith-street, and part of Week-street by means of arc lamps, but as this would involve an initial expenditure of about £1,200-£1,500, and an increase of the present cost of lighting the same streets amounting to about £150 per annum, and as also it might cause a certain amount of the trade to be diverted to those streets from other portions of the town not so brilliantly lit, I would recommend the Board to leave the improvement of the street-lighting till such time that it is satisfied that the supply of electricity to the private houses and business premises shows a sufficient profit to justify it in using the surplus towards the improvement of the public lighting throughout the borough. I think it is quite unnecessary at the present moment to deal with the question of lighting the whole of the borough, as the sale of current would not for some time yield a sufficient return for the large outlay and heavy maintenance bill involved. The system advocated offers every facility for extension, ample room is provided at the generating station for additional plant, the staff employed in the first instance need not be augmented for some time, and the generating plant and street mains need only be increased as the demand for current increases, and the mains will then be laid only where the revenue to be derived from them will repay the Corporation for the expense incurred by their construction and maintenance. I do not consider it would be advisable to run distributing mains along the Fair Meadow, Medway-street, Market-street, the lower part of Faith-street or Havock-lane, or Pudding-lane, as there is not likely to be much demand for current in any of these streets. I would propose, however, to run mains throughout the whole of Week-street, down Gabriel's-hill, as far as Knightrider-street, along King-street to Church-street, and on the north side of the river along the part known as Broadway as far as the South-Eastern Railway Station, as I think this should bring in many more customers. The Board of Trade will not compel us to run mains in the first-mentioned batch of streets unless there is an actual demand for the light in those streets, though if a demand is made they may then order us to meet it, these streets having already been scheduled in the compulsory area. Altogether the total length of distributing mains would be about 2,500 yards, which means a frontage of 5,000 yards, and along these mains I think we could safely count on obtaining 2,000 lights, or less than half lamp per yard of frontage—a very low estimate, practice showing that 1 to 1½ lamps per yard of frontage may safely be relied on, and this in districts far more scattered than in the portion of this town now dealt with. I had hoped from accounts that were given me of being able to find a certain amount of water power available for running a portion of the plant, but I have now carefully examined and tested the amount of power to be derived from the different falls both up and down stream on the Medway, and also on the River Len, at Mill-street, and I find that the horse-power on which we could depend is so fluctuating in the first case, and so small in the second case, that it would not pay to utilise it. The scheme then resolves itself into one in which only steam generating plant could be employed, and on going into this I find that it would be better to abandon the idea of placing the generating station on the Fair Meadow as at first proposed, and to place it on the site of the Corporation's sewage works. My reasons are: 1. The ground is not nearly so valuable. 2. The ground being higher, the question of flooding need not be considered, and consequently the cost of the building, which would be £3,000 at the Fair Meadow, would be reduced to £1,500 at the sewage works. 3. There would be an absence of "smoke nuisance." 4. The labour at present employed in running the sewage plant would be quite sufficient to run the plant for the town electricity supply during two-thirds of the day, and in this way the maintenance of the electricity supply plant would be greatly reduced. 5. Water is available as at the Fair Meadow, and coal can be delivered at the same cost as at the above site. 6. I have interviewed Major Cardew, of the Board of Trade, and he will, on receipt of a letter from the Local Board, grant us permission to run overhead cables along the towing-path to the town. The cost of running these mains in duplicate will be covered by an expenditure of £600. The system to be employed should be that best described as a combined high and low tension system, preferably on the alternate-current transformer principle—that is to say, the generating station would contain plant working at a high tension—1,000 to 2,000 volts. From here to the town the current would be carried at this pressure, but throughout the town a low-pressure system of mains would be employed for feeding the premises of the consumers, and the current would be reduced by suitable transforming devices placed at intervals throughout the town, and feeding into this low-pressure network. All transforming devices would be under the direct and sole control of the Corporation, and the high-pressure mains would never be interfered with and would only be accessible by the Corporation's officials. The advantages of such a system are very great, and it is only by a system of this sort that we can hope to eventually extend the lighting area so as to embrace the whole of the borough; moreover, the cost of extension would not be very great, and we should be able to meet any reasonable demand for current, no matter how far off within the borough boundary the premises of the applicant for the light might be situated. I have made no reference hitherto as to the supply of current for motive power, as I think we should have very little demand for this at present; still, as this might be an additional source of income, there is no reason why we should not supply current for this purpose at a special rate during that portion of the day, say, between 5 a.m. and 5 p.m., when only a small lighting load is to be expected. The cost of such a system, including the extension of mains in the streets named above, would be between £10,000 and £11,000 at most; but it is advisable to obtain powers to borrow a good deal more than this, say, 50 per cent. more, to cover extensions without again appealing to the Local Government Board. Now the income derivable from sale of current is at the rate of £491. 13s. 4d. for every 1d. per unit charged to the consumer, so that if the consumer were supplied at the price of 6d. per unit, the sale of current would

realise	£2,950
Contra working expenses	2,292
Realised profit	£658

The amount to be written off for repayment of capital and interest would be 4¼ per cent. on the sum first called up, say, £10,500—

Profit	£658	0	0
4¼ per cent. on £10,500	446	5	0
	£211	15	0

Therefore the undertaking would show a small profit even at a charge of 6d. per unit, which is about the equivalent of gas at 4s. 6d. per 1,000 cubic feet. I would, however, recommend the Board to charge 6½d. per unit in the first instance, and this would show the electric light as the equivalent of gas at 4s. 10½d. per 1,000. I have been asked to give some figures, for the benefit of the consumer, dealing with the relative cost of electricity and gas, and also with the cost of installing the electric light in houses and business premises. As regards the relative cost of electricity and gas, it has been proved by some of our most eminent authorities that the average gas-burner gives a light of not more than 12 c.p. for every five cubic feet of gas consumed, while an incandescent lamp of 16 c.p. requires some 60 watts. At this rate the gas required for 16 c.p. $=\frac{16 \times 5}{12}=6\frac{2}{3}$ cubic feet. Now one Board of Trade unit=1,000 watts. The relative cost of gas and electricity is therefore—

(1) 6⅔ cubic feet of gas at 2s. 6d. per 1,000=0·20d. per hour.
(2) 60 watts of electricity at 6d. per 1,000=0·36d. ,,
(3) 60 ,, ,, at 6½d. per 1,000=0·39d. ,,

or for a similar amount of light.

Electricity at 6d. per unit costs 4s. 6d., where gas costs 2s. 6d.
,, at 6½d. ,, 4s. 10½d., ,, 2s. 6d.

This is by no means unfavourable to the electric light, when we bear in mind that allowance should be made for (1) non-destruction of decorations and shop materials; (2) greater economy in house-lighting owing to the ease with which the light may be turned on and off, as required; (3) non-vitiation of the atmosphere. I would also point out that, although the 16-c.p. incandescent lamp at present manufactured by the Edison-Swan Company requires 60 watts, there is no doubt that immediately this company's patents have expired, towards the end of the present year, lamps will be placed on the market which will require very little more than half of this amount for the same candle-power. Many well-known manufacturers are openly avowing this, and it will be seen that the figures I have given above as to the cost of the electric light will be so reduced that electricity will become as cheap as, if not cheaper than, gas at 2s. 6d. per 1,000 cubic feet. As regards the cost of installation, many firms in London are now charging an average price of 25s. per lamp for wiring premises for the electric light. This price only includes plain fittings of the pendant type, but there is nothing more effective than this style of fitting for general purposes. It is generally assumed that one 16-c.p. lamp is required for every 100 square feet of floor to be illuminated. I have no figures for gas illumination by me, but supposing 16-c.p. incandescent lamps were to be substituted for actual 16-c.p. gas lamps, it stands to reason that the floor would be better illuminated than before, because a reflector can be placed immediately above the incandescent lamp to throw the light downwards where it is required, instead of as with gas, where reflectors cannot be used to the same advantage, wasting the light on places where no light is required. A full description of the plant, with estimated expenditure and revenue, is attached, together with a general specification which I have left purposely open, and I would recommend the Board to ask for tenders from a few of the principal contracting firms as soon as possible, that its decision may be arrived at with a minimum of delay, and that it may see that so far from the establishment of an electricity supply station causing an increase of the rates, it will assuredly leave a margin of profit almost from the commencement, as is the case in St. Pancras, and in other districts where the local authorities are themselves the suppliers.

Cost.

To erect and equip an electricity supply station at the Corporation's sewage works to supply in the first instance current for about 2,000 16-c.p. incandescent lamps, distributed as follows:

Public buildings	500
Shops, houses, etc.	1,500
	2,000

And, if necessary, to erect plant for about 20 arc lamps of 2,000 nominal candle-power each, to be erected in High-street, Bank-street, and Week-street. With 2,000 lamps installed, working on the assumption that not more than two-thirds of this number will be alight at one time, we find the total plant necessary will be that required to supply about 1,300 lamps—*i.e.*, 78,000 watts; but in that some time may elapse before the number is obtained, we may cut down this figure somewhat—I would, therefore, split up the plant as follows:

One set	dynamo and	engine of	50,000 watts.
One	ditto	ditto (spare) of	50,000 ditto.
One	ditto	ditto of	25,000 ditto.

This would allow of all the lamps being run at one and the same time, should such a thing be necessary, or with nearly two-thirds of the lamps going at one time would give us a spare plant of 50,000 watts. The probable sale of electricity is based on the assumption that the load factor would be 17 per cent. of the maximum current supplied at one time (not the maximum possible output at the station). In residential districts it is fair to assume that not more than half the number of lamps will be in use at one time, but in districts where shops, business premises, and the like predominate, it is found that a ratio of from 60 to 90 per cent. comes nearer the mark, and this is especially the case in new districts, where it is found that those who take the light seldom put in more lamps than they actually require. It would therefore not be under the mark to reckon on a load factor of 20 per cent., especially when it is borne in mind that this does not mean 20 per cent. of the total lamps installed (2,000)) but 25 per cent. of the two-thirds portion of this number (1,330 lamps). Still, reckoning on the assumption that the load factor is only 17 per cent. of this number of lights, the sale of electricity in Board of Trade units would be:

$$\frac{1{,}330 \times 60 \times 24 \times 365 \times 17}{100 \times 1{,}000} = 118{,}838. \quad \text{Say } 118{,}000.$$

Now 118,000 Board of Trade units at 6d. per unit = £2,950 0 0
" " " 8d. " = £3,933 0 0

Now the probable cost of the undertaking being shown at £10,450, we may proceed to consider the working expenses, which will be made up as follows:

Labour and Supervision.		
Engineer's salary	£300 0 0	
Two drivers at 35s. (see note)	182 5 0	
Two dynamo hands at £100	200 0 0	
Two stokers at 22s. (see note)	115 4 0	
Add 10 per cent. sundry labour	73 0 0	
		£870 9 0
Depreciation.		
Running plant, 7½ per cent. on £4,500	£337 10 0	
Conductors, 4 per cent. on £3,900	156 0 0	
Buildings, 3 per cent. on £1,500	45 0 0	
		£538 10 0
Materials.		
Coal, 1,053 tons at 12s. per ton	£633 0 0	
Oil, waste, etc.	50 0 0	
		£683 0 0
Office expenses and collection		200 0 0
Say, £2,292.		£2,291 19 0

Note on Item for Labour and Supervision.—Assuming that one driver and one stoker are employed for 16 hours a day (or two drivers and two stokers for eight hours, which is the same thing), at the sewage works, and that these men could easily handle the electricity supply plant at the same time, we can divide their time, charging half to the sewage works and half to the supply station; we should then require one additional driver and one additional stoker for the remaining eight hours of the day. The supply station would then be maintained by (apparently) two drivers and two stokers, and the annual cost of running the sewage works would also be reduced by half driver's pay and half stoker's pay, or about £149 per annum.

PROVISIONAL PATENTS, 1893.

February 6.

2552. **Improvements in the construction and control of arc lamps.** Robert Pippette, 31, Endymion-road, Brixton-hill, London.

2557. **Improvements in and connected with electrically-driven screw propellers.** Harry Theodore Barnett, 14, Narcissus-road, West Hampstead, London.

2583. **Improvements in electrical indicators, which improvements are also applicable to electric bells, watches, or other apparatus.** George Hayward, 90, Hatton-garden, London.

2586. **An improved diaphragm for electrolytic cells.** Charles Nelson Waite, 47, Lincoln's-inn-fields, London.

2593. **Improvements in or connected with telegraph-pole fittings.** John Crisp Fuller, George Fuller, and William Edward Langdon, 33, Chancery-lane, London.

2598. **Processes for effecting the electro-deposition of metals upon aluminium.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (George Lehnert, Germany.)

2600. **Improvements relating to electric incandescent lamps.** Reginald Haddan, 18, Buckingham-street, Strand, London. (Gaston Dedreux, Germany.) (Complete specification.)

2632. **Improvements in electric lighting.** George Robert Rollason and Charles Arthur Rollason, 54, Fleet-street, London.

February 7.

2672. **Transmission of power by high-potential direct currents of electricity.** Charles Schenck Bradley, Ranald Trevor McDonald, and Robert Stewart Taylor, 97, Newgate-street, London. (Complete specification.)

2674. **Improvements in combined electric cut-outs and door locks.** John Hite Lee Holcombe, 1, Quality-court, Chancery-lane, London. (Complete specification.)

2696. **Improvements in teleautographs or writing telegraphs.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Elisha Gray, United States.) (Complete specification.)

2703. **Improvements in high-tension electrical fuses.** Darwin Bates, 24, Southampton-buildings, Chancery-lane, London.

2740. **Improvements connected with electric arc lamps.** John James Rathbone, 166, Fleet-street, London.

2725. **Improvements in incandescent electric lamps.** William Frederick Taylor and George Frederick Barnes, Boswell Court, Croydon.

February 8.

2744. **Improvements in the means for applying the static electrical brush discharge to the human body for curative purposes.** Walter Claypole, Hall-lane, Woodley, near Stockport.

February 9.

2888. **Electric fog signal.** Herbert Brocklehurst and Henry Constein, 24, Cheyne Court-mansions, Chelsea, London.

2922. **Improvements in electric clocks.** Herbert Scott and Henry King Burnet, 27, Welbury-drive, Bradford, Yorkshire.

February 10.

2940. **Improvements in the electric dissociation or modification of gases, gaseous compounds and products.** John Emerson Richardson, Imperial-chambers, Albert-street, Derby.

2946. **Improvements in or relating to galvanic batteries.** Richard Joseph Crowley and John Russell Grant, 42, Lamb's Conduit-street, London.

2992. **Improvements in bearings for shafts or axles, more especially adapted for dynamo-electric machines, electric motors, pulley-blocks, and similar apparatus.** Albert Gascoigne, 47, Lincoln's-inn-fields, London.

February 11.

3053. **Electric light display system.** Frederick William Golby, 36, Chancery-lane, London. (Daniel McFarlan Moore, United States.) (Complete specification.)

3071. **Improvements in or connected with automatic electric signalling on railways.** The Automatic Electric Railway Signal Company, Limited, and Edwin Blakey, 78, Fleet-street, London.

3073. **Improvements in telephones and telephonic and telegraphic relays.** Maxymilian Kotyad and Walker Moseley, 60, Watling-street, London.

3092. **Improvements in electric arc lamps.** Leonard Albert Hindley, 54, Fleet-street, London.

3101. **Improvements in armature insulators.** Charles W. Jefferson, 38, Chancery-lane, London.

3118. **Improvements in electrical conductors.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

3119. **Improvements in the formation of solid ends on flexible or compound electrical conductors.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1889.

4875. **Electrical transmission of power for traction purposes.** Immisch. (Second edition.)

14,113. **Electrical switches.** Immisch. (Second edition.)

14,114. **Switch for electrical tramcars.** Immisch. (Second edition.)

1892.

843. **Incandescent lamps.** Coad.

936. **Transmitting and receiving apparatus.** Shuckert and Wacker.

3233. **Electrically-driven machines.** Rawson and others.

4841. **Electric railway trains.** Spence.

5141. **Electric circuits.** Snell and others.

5528. **Coin-freed telephonic apparatus.** Booth. (Hermann.)

17,169. **Electrolytical decomposition of metallic salts.** Kellner. (Second edition.)

21,830. **Electrical conductors.** Atkinson and others.

22,375. **Welding metals electrically.** Thompson. (Coffin.)

22,987. **Secondary-battery plates.** Justice. (Griscom.)

23,086. **Telephone communication.** Smillie.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2 7/16
City of London	—	12½
Electric Construction	10	2¾
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	5⅞ 4⅛
London Electric Supply	5	¾
Metropolitan Electric Supply	—	6¾
National Telephone	5	5 5/16
St. James'	—	8
Swan United	3½	3 5/16
Westminster Electric	—	5⅞

NOTES.

Rail-Welding.—The welding of rails by electricity has come into extensive practice in America during the past year.

Royal Institution.—Dr. E. Hopkinson will lecture on "Electrical Railways" before the Royal Institution tonight, at 9 p.m.

Tasmania.—The electric railway installation for Hobart Town, Tasmania, is being rapidly got into place, and will be working shortly.

Electro-Harmonic.—A ladies' night concert will be given by the Electro-Harmonic Society to-night, at St. James' Hall Banquet-room.

Glasgow.—The formal inauguration of the Glasgow central electric supply will take place on Saturday, when Lord Provost Bell will switch on the current.

Heilbronn.—A description of the three-phase transmission to Heilbronn is given in convenient form in the *Zeitschrift für Elektrotechnik* of Vienna for February 15.

Inland African Telegraphs.—Direct telegraphic communication has at length been successfully established by the German Government between Germany and the Cameroons.

Electrical Engineering at College.— Columbia College has created an independent branch for electrical engineering, and Prof. F. B. Crocker has been appointed to the first professorship.

Berwick.—At the quarterly meeting of the Berwick Local Authority last week, it was reported that the Lighting Committee have in preparation a scheme of electric lighting for the borough.

Cadmium Accumulators.—We hear, says the *Bulletin Internationale*, that a project is discussed for the electric lighting of a town in the suburbs of Paris by means of cadmium accumulators.

Liquid Air.—In the presence of the Prince of Wales, the Duke of York, and a distinguished audience of scientific men, Prof. Dewar repeated, at the Royal Institution, on Wednesday, his lecture on "Liquid Atmospheric Air."

Popular Electricity.—A series of short popular articles on electricity and its present day applications, is appearing in the *Reading Mercury*. The first article gave some idea of electric lighting, and the second deals with traction.

Milan.—For the international electrical exhibition at Milan in 1894 there is some talk of transmitting 40,000 h.p. electrically from the waterfalls at Tornavento, the power to be distributed for lighting and power throughout the district.

Aluminium Balloons.—It is announced from Lyons that MM. Gouttes and Sibillot have made experiments with the view of adopting aluminium as the material for the gasholders of dirigible balloons instead of silk or other stuffs, with satisfactory results.

Development of the Telegraph.—A lecture on this subject was given at Nottingham, on Monday, by Mr. Samuel Vyle, chief electrician to the colony of British Guiana. The Mayor presided, and the lecture was illustrated by apparatus lent by the General Post Office authorities.

Carriage-Lighting. — The electrical exhibition at Frankfort has not been without its effect on the public mind, for we learn that a cab is in regular use at Frankfort lighted by electric light by means of accumulators. This enterprise will shortly cause competition among other cab-drivers, and a regular service of electric light for the carriages is anticipated.

Project for Strassburg.—We have received from Herr O. Von Miller, of Munich, a copy of his "Project for the Electric Light Station of Strassburg." It is issued in the form of an imposing book, containing full details and a large number of carefully-drawn plans and diagrams of apparatus, supply curves, and so forth, coloured. We shall refer to this project again in another issue.

City Lighting.—It is now found very difficult to obtain accurate and full information on the huge electric lighting enterprise of the City of London Company. But we hope electrical engineers will not have long to wait, for perhaps it will not be indiscreet to mention that it is currently reported that before long Sir David Salomons, the chairman of the company, will himself read an exhaustive paper on this subject.

Winding.—M. Rechniewski, in *L'Electricien*, continues a series of articles on the winding of armatures. In the number for February 18, he discusses the winding of multipolar machines for continuous-current, ring, drum, and disc type. He gives credit for some of his diagrams to Arnold's "Ankerwickelungen der Gleichstrom-Dynamo-Maschinen," of the Wodicka process of winding, and will deal with the Fritsche and Desrozier armatures in a third article.

Electric Light Waggon.—The newest arrangement of electric light waggon by Messrs. C. and E. Fein, of Stuttgart, is illustrated in the *Elektrotechnische Zeitschrift* of 17th inst. It has a Westinghouse high-speed engine and a Fein dynamo, with vertical boiler. The engine is 5 h.p., at 500 revolutions and 75lb. pressure. The dynamo gives 3,000 watts, and the efficiency of engine and dynamo is 80 per cent. The current used is 65 amperes at 120 volts, and the total weight of the apparatus is 4,500 kilogrammes, or 4½ tons.

Civil Engineers.—At the meeting of the Institution of Civil Engineers on Tuesday, when the discussion was renewed upon Dr. Edward Hopkinson's paper on "Electrical Railways," there was a small exhibition of models and photographs of electrical appliances, including microphones and telephones. By permission of Mr. Horace Sedger the rooms of the institution were placed by the National Telephone Company in communication with the Lyric Theatre, by which the members were enabled to hear selections from "The Magic Opal." An exhibition of electric cooking was shown by Messrs. Crompton and Co.

Death.—The death is announced of Prof. Stefan, who held the chair of physics at the Vienna University. He was the author of many contributions to physical science, especially upon electrical matters, more particularly on the phenomena of alternate currents and electric oscillations. He was president in 1883 of the Testing Committee at the electrical exhibition at Vienna, and published a most interesting report dealing largely with alternate currents and their measurement. Prof. Stefan had a high reputation in his own country, though not very largely coming before the notice of engineers in this country.

Eight Hours.—Every electrical engineer will watch with interest the industrial experiment now introduced by Messrs. Mather and Platt, of the Salford Ironworks, who have intimated to their workpeople that from Monday last they intend to try the experiment of working only 48 hours a week, instead of 53 as hitherto. The experiment is to extend over 12 months, and the firm hope to be recouped to a considerable extent for the sacrifice by increased energy and greater punctuality on the part of their workmen. The start before breakfast will be abolished, and the day's work will commence at 7.30 a.m. and cease at 5 p.m., with an interval for dinner.

Traction at Croydon.—Mr. W. J. Carruthers-Wain, chairman of the Croydon Tramways Company, mentioned at the sixth ordinary general meeting of the company held yesterday, that they continued to receive a variety of offers for introducing various kinds of mechanical traction, electrical or otherwise. Their line was very favourably situated for demonstrations of that nature. The shareholders might possibly have heard or read in the newspapers something about the matter, but he assured them that the directors did not intend to allow their line to be worked on any system without entering into agreements which were reasonably in favour of the company.

Arc v. Incandescent.—The engineer at the Barry Docks, writing with reference to the recent discussion of the merits of high candle-power arc and incandescent lamps, says that at the Barry Graving Docks may be seen all types of lamps in actual use. The company have the whole of their extensive premises illuminated with arc and incandescent lamps. They have 120 incandescent lamps, from 8 c.p. to 500 c.p., and six arc lamps of 2,000 nominal candle-power, and they find that each arc lamp on their premises illuminates an area of 3,000 square yards and absorbs 1 h.p. each, and that each 300-c.p. incandescent lamp illuminates an area of 200 square yards and absorbs 1 h.p.

Maximum Speed.—A calculation by J. Krämer in the *Elektrotechnische Zeitschrift* on the maximum speed for an electric railway, is thus abstracted in the *Journal* of the Institution: "The theoretical maximum speed of a perfect motor on rails is taken at 500 kilometres (310 miles) per hour. This is on the level, with curves of not less than 20 kilometres (12 miles) radius, and 12ft. driving wheels. The problem of an electric locomotive and two cars is then investigated at considerable length, and the author appears to have considerable doubts whether the proposed 250 kilometres per hour on the projected Vienna and Budapest line of Messrs. Ganz is feasible. The author would put the maximum at not more than 200 kilometres (120 miles), if as high."

Electric Music.—A sensational item in the programme of amusements at Liverpool Grand Theatre of Varieties is the "electric music" played by Miss Dot D'Alcorn. In a mephistophelian costume this lady takes her seat at the organ, and as her fingers glide over the manuals most extraordinary musical effects are produced, from the most delicate strains to the full power of a numerous orchestra. "Frequent intermittent flashes of electric light play round the heads, and even the feet, of the audience; salvos of artillery are fired off, objects of interest appear and disappear, and a train is set in motion on a circular railway. Eventually during the raging of the storm Miss D'Alcorn vanishes under cover of a terrific peal of thunder and a blinding flash of lightning."

Three-Phase Currents.—The first three-phase current plant in the United States will be put down at Concord by Mr. Eugene F. Carpenter. Two 250-kilowatt generators will be used, at 2,500 volts, reduced to 250 volts at the motors, of which 700 h.p. are already let. The falls at Sewall are capable of developing 5,000 h.p. The power plant will consist of five 400-h.p. turbines, driving pulleys on hollow shafting. There will be two 2,000 light alternators and five 50-light arc dynamos beside the three-phase machines, which are specially for motive-power distribution. The ultimate capacity will be double. The company has a 10-year contract for lighting the town, and 6,000 incandescent lamps are already contracted for, so this undertaking starts under good auspices.

Chamber Transformer.—A piece of apparatus that may prove useful enough under many circumstances in laboratory or workroom is a small Ruhmkorff coil acting as transformer, made by E. Ducretet et Cie., of Paris. It is strongly made for serviceable use, and the current from a couple of ordinary cells passed into the primary supplies 100 or 150 volts at the secondary. Some such apparatus as this would be useful to photographers and lecturers; a single large dry cell primary, or preferably secondary, would give a large current at low voltage and be easily transformed up to 60 volts, sufficient for an arc lamp. The buzzer might be put into a sound-proof chamber, so as not to emit a disturbing noise.

Magnetism and Temperature.—In a paper to the French Académie des Sciences, M. Curie sets forth his researches into the magnetic properties of various diamagnetic bodies at different temperatures. Most of these have a remarkably constant coefficient of magnetisation, which is not influenced by change of state nor variations of temperature. It is thus for sulphur and water; nitrate of potass, iodine, selenium, melt without variation in their magnetic properties; but for antimony and bismuth the coefficient of magnetisation decreases rapidly with increase of temperature. The results are interesting to compare with those of magnetic bodies whose coefficient of magnetisation decreases with increase of temperature, but with a variation less and less as the temperature increases.

Electricity for Photographers. — At the last meeting of the Berlin Medical Society, Dr. Lassar showed some photographs, in life size, says a note from the Continent, hitherto been impossible to take direct from the sitter. The difficulty has been overcome by Herr Haag, in Stuttgart, by means of a change in the management of the magnesium light. Herr Haag has made some lightning cartridges, which cause a tremendous development of light, and are set alight in one-tenth of a second by means of electricity. The so-called "natural photographs" preserve the mental expression and momentary play of the features with extraordinary clearness and exactitude. Success demands much practice and cleverness, and such photographs are at present only made by a single photographer in Berlin, and are still very expensive.

Antwerp.—The latest idea of M. Van Rysselberghe, who has just died at the untimely age of 46 years, was the establishment of a system of hydro-electric distribution in Antwerp. The sudden death of the originator of the scheme in the town itself has left the scheme without a guide, and it will remain to be seen what steps will be taken in Antwerp to continue the establishment of a system of electric lighting and distribution of power for which there is a great field in this seaport. Antwerp has also been a frequented port, and has during late years taken a turn in active establishment of new works, in somewhat a similar fashion to the sudden growth of Cardiff in this country. It is to be hoped that the project now practically settled will not be left for want of an active advocate.

New Continental Service.—A steamer intended for the Great Eastern Railway Company's Harwich continental service was on February 21st launched from Messrs. Earle's yard, at Hull. This vessel is a steel twin-screw steamer, 300ft. in length, by 34½ft. beam, fitted with two separate sets of triple-compound engines, which are expected to develop 4,500 h.p., the builders having guaranteed a speed, when fully loaded with passengers and cargo, of 17½ knots per hours. The christening ceremony was performed by the Mayoress of Chelmsford, the vessel being named after that town. She is fitted with all the latest improvements, including a complete installation of electric light, for about 200 first-class passengers, and is intended for the new route to the Continent from Harwich *viâ* the Hook of Holland, which is expected to be opened on the 1st June next.

Heat of the Arc.—In the investigations undertaken by M. Violle on the temperature of the arc, he states that the amount of heat necessary to raise one gramme of graphite from 0deg. C. to the temperature of the volatilisation of carbon will be 1,600 calories-gramme-degree centigrade. It is taken that 300 calories are required to heat one gramme of graphite from 0deg. to 1,000deg. C. There remains 1,300 calories for heating to volatilisation. According to the theoretical specific heat of graphite (0·52), the 1,300 calories represent 2,500deg. C., which gives finally 3,500deg. C. as the temperature of volatilisation. M. Rossetti, in 1879, in a paper printed in the *Annales de Physique et de Chémie*, gave the higher figure ot 3,900deg. C. Certain experiments of M. Vieille went to show that at about 3,200deg. C. there was a noticeable pressure of the carbon vapour. These figures do not detract from the value of M. Violle's investigations, which, for the first time, has given to physicists an accurate statement of the temperature of the electric arc.

Military Searchlight.—Captain Ronald Scott, whose portable searchlight has excited so much interest, occupied the chair last Saturday evening at the annual dinner of the F Company, which he commands, of the West London Rifles (4th Middlesex), held at the Horseshoe Hotel, Tottenham Court-road. In responding to the toast of his health, he referred to the improvements he had been able to make in his light since it was first used at Elstree, when they had to transport a dynamo to the field of operations and pin it to the ground with stakes. He had, he said, now designed a waggon, which he expected to have completed in a few days, in which the whole of the apparatus could be easily and quickly transported from point to point, and this he would be able to use at Huddersfield on March 18, when some extensive night operations would, with its assistance, be carried out by the Yorkshire Volunteers. He had recently been asked to attend at the Horse Guards to consult with the authorities there as to the use of his light, and he thought it probable that within a short period they would test its capabilities at a big night attack not very far from London.

Publishing by Telephone.—The Vienna correspondent of the *Standard* announces that a copy of the first so-called "telephonic newspaper" appeared in Pesth last Sunday. In other words, the latest items of news—political, local, commercial, sporting, and other—are sent out from a central office by telephone to the subscribers, who, for this intelligence, pay the very modest sum of only some three shillings a month. This novel undertaking comprises at its central office two departments—a regular editorial office, which receives the telegraphic and oral messages, and works them up into leaders or paragraphs; and a special telephonic publishing department, where experienced speakers, each possessing a soft but distinct voice, transmit through the instruments the contents of the manuscripts delivered from hour to hour by the first department. There are two languages used — German and Hungarian. The news includes Stock Exchange quotations and financial articles, reports of theatrical performances, book reviews, and paragraphs on all the miscellaneous topics found in a daily newspaper. The subscribers who receive the news have a square wooden tablet before them, from which are suspended two tubes long enough to reach their ears when they are sitting in an easy-chair or at a writing-desk, or even when lying in bed. The service commences at eight o'clock in the morning, and lasts till nine in the evening. The novelty has, so far, been very well received in the Hungarian capital.

Alternate-Current Measurement.—Prof. Fleming brought to an end his instructive series of lectures on the practical measurement of alternate currents by showing and describing the many practical forms of meter now before the electrical profession. The electrostatic wattmeter of Lord Kelvin, previously alluded to, is described elsewhere. The Thomson, Cauderay, Aron, Frager, Brillé, and Ferranti meters were specially dealt with, and methods of connecting up alternate-current wattmeters by the use of transformers was fully worked out, and the diagrams of connections shown. Prof. Fleming maintains that from henceforth every alternate-current station can and should have apparatus for measuring with exactitude both the energy in watts sent out on the primary as well as the apparent amperes and the volts. A 24 to 1 transformer of special make to secure high efficiency at every load should have its low and secondary wire connected first to a couple of lamps and then to the voltage coils of alternate-current wattmeters. Two wattmeters should be used—one on which readings are periodically taken, and the other a self-registering instrument. The ampere coils of these wattmeters take the whole station primary current, which is thus measured directly in watts, while an ampere-meter measures the apparent amperes. An electrostatic voltmeter on the 100-volt mains completes the set of measuring instruments, which no alternate-current station should be without, and with which all necessary measurements can be easily and simply made.

Pioneers in Dynamo-Building.—Mr. Wm. T. Hammer contributes an interesting piece of dynamo history in a description, in the New York *Electrical Engineer*, of the early work of Mr. William Wallace. This little-remembered pioneer was the first builder of dynamos in America and the first to apply them to electroplating. An illustration of the Wallace dynamo of 1874 is given, looking very like an inverted Edison machine, and very mechanical in appearance. A curious anecdote of Wallace is mentioned as given by Mr. Sprague in the early days, before motors were thought of as useful machines. Said Wallace: "Sprague, let me show you something." He had one of the old two-pole armature machines, and had it connected to a dynamo. He turned on the current, and pretty soon had the armature spinning at two or three thousand revolutions a minute. He said, "It is no good, though," and when asked "why?" said he would show the reason. He called to a strong man and told him to take hold of the pulley, which was about 10in. diameter. The man threw his arms around it, lowered its speed, and soon brought it to rest. "In that simple experiment," says Sprague, "he outlined and overlooked the most important fact he had to deal with—that the work done was not determined by the torsional effect alone, but that this should be multiplied by the speed of the rim. Had Mr. Wallace seized on that single point, or had I, at that time, the transmission of power would then have been very much advanced." Mr. Wallace's most practical pioneer efforts were led on one side by other interests, and we do not hear as much of his record as he seems to deserve.

Coast Communication.—In the House of Commons on Thursday last week Admiral Field asked the President of the Board of Trade whether he had considered the report of the Royal Commission on Electrical Communication with Lightships and Lighthouses, and was prepared to carry out, in conjunction with the Postmaster-General, the recommendations contained therein in respect of the five light-vessels, the 17 shore lighthouses, and the "Gunfleet" pile lighthouse, which they advise should be connected by telephone immediately as being the most economical and most easily worked by men not specially trained; also as regards the three light houses on Caldy Island, Lundy Island, and the Tuskar Rock, would he carry out the recommendation to connect them by telephone with continuous cables and the Fastnet lighthouse with a non-continuous cable as recently tried at the Needles, and whether he would call the attention of the Trinity Board to the fact that three of the five vessels named are considered unsuitable for the electrical communication recommended, with a view to their being replaced by vessels of a more efficient class? Mr. Mundella replied that he was in communication with the Treasury and the Postmaster-General on this subject, and assured the hon. and gallant gentleman that it was receiving constant attention. On Tuesday, in answer to Mr. Gourley, Mr. A. Morley said: As I have already stated to the House, the sum of £20,000 voted last session for special sea-coast extensions has been wholly appropriated, and will be expended before the end of the financial year. I have no information beyond what is to be found in the public newspapers as to whether the system has been the means of accelerating the despatch of lifeboats and of saving lives, and I have communicated with my right hon. friend the President of the Board of Trade, and I understand that he is in the same position. As to the proposals of the Royal Commission on Electrical Communication with Lighthouses and Light-vessels, which are distinct from the scheme of coast extensions sanctioned by Parliament, they are now under the consideration of the Treasury.

Triphase Currents.—According to recent experiments made by Mr. Hans Görges in Messrs. Siemens and Halske's laboratory, the difficulties of regulating triphase dynamos which occur when the circuits are not equally loaded, may be easily overcome by a judicious choice of combinations, in star or triangle shape, of the arrangement of the conductors. The number of combinations which may be made, taking one or other of these shapes, for the dynamo, the primary and secondary of transformer, and of the lamps, is 16. Some of these arrangements are unsatisfactory, giving variations of voltage of 50 per cent. when the branches are unequally charged, but most of them give satisfactory results, and a few give differences so small that practically they are negligible. With these, under the most unfavourable circumstances—when two circuits are fully charged and the other has no load, or when one is fully charged and the two others have no load—the variations of voltage do not exceed 6 per cent. With less variation of load the variation of voltage is less. For instance, if the difference of load is 30 per cent., the variation of voltage is only 2 per cent., or 1 per cent. with reference to the mean value. These figures have been obtained with a dynamo and transformer of 50-kilowatt capacity whose circuits were unequally loaded. It is found that the variations of dynamo and transformer are added together, so that if fed direct the variation at the lamps will not exceed 3 per cent. under the most disadvantageous conditions. Besides the combination of groupings in star or triangle shape, other causes exist which influence the variation of voltage; for instance, the construction of the dynamo, the strength of exciting current, as well as the loss in the transformer. If the excitation is low the reaction of armature is considerable, and the variation of voltage becomes important. The results given above are when the excitation is normal, and the loss in transformers is 2½ per cent. Experiments were also made with reference to the regulation of voltage, either before or after the transformers, at a distance from the generating station. The voltage was raised by a first transformer and then reduced to the ordinary lamp voltage by a second transformer. This regulation, which is brought about by resistances, succeeded perfectly in the case where two circuits are open and the other loaded, and in the case of two circuits loaded and one open the result was fairly satisfactory. M. Görges arrives at the conclusion that the division of lamps in three groups presents no practical inconvenience, and that putting synchronous motors in the circuit keeps the voltage more constant the more are used, as their introduction tends to equalise the load.

Storage.—Every electrical engineer who has to design a central electric station or to keep such a station up to its maximum efficiency is well aware of the importance of the question of storage. He has probably more or less clearly made up his mind for the present in one direction or the other, but is conscious that the problem of sufficient storage of energy is one that is not yet entirely and satisfactorily answered. The use of secondary cells as accumulators in central-station work has not been so universally adopted as was anticipated at their introduction. Instead of acting as the reservoir from which all excessive demand at times of heavy load should be supplied, this *rôle* has been kept by the engine and dynamo, and only that part more subsidiary, though useful enough, of supplying the current during the small and early hours, has been regularly taken, even in continuous-current stations, by the accumulators. The fond idea that small and efficient engines should be kept constantly running to accumulate electrical energy, has not been found to work perfectly in practice; it is better to start up more engines as the demand increases. Accumulators, in fact, are not able to return the energy in the same way that pumped water is able to do, and the idea seems growing in favour with electrical engineers that in engineering work mechanical storage may be preferable to electrical storage. Such, apparently, is the outcome of Prof. Unwin's study of the question in his papers before the Society of Arts, and in this he seems to bear out the recent contention of Prof. Forbes, whose advocacy of water storage instead of electrical as a stand-by is well remembered. The various forms of storage of energy that promise practicability at the present time—besides the primary one of coal—are: superheated water, water raised in level, compressed gases, and forced chemical activity, either in what is known as storage of electrical energy or other. There is, besides these, the storage of negative heat energy in the form of cold, as in liquefied gases, a form of storage which, it is not too much to say, may develop into unexpected practical importance before very long. But the tendency of the engineer is to prefer to deal with engineering forces rather than with chemical or etheric forces; and while we are still dealing with the long vibrations of heat energy as now, instead of the short vibrations of phosphorescence, it is undeniable that the management of mechanical forces is more satisfactory to the engineer than the manipulation of more abstruse reactions. There is the added reason, for the present, that mechanical storage of power is equally applicable to alternate current generation as to continuous currents. The outcome of the discussion will probably be a searching of hearts among the electrical engineers as to the practical merits—in terms of Board of Trade units and pounds sterling—of water storage, of heat storage—positive and negative—and of chemical or electrical storage. When all the concomitants are considered, the discussion may become as interesting as that which has now almost begun to pall upon the taste between alternate and direct current distribution.

Long Electric Railways.—We are on the verge of something very large in electrical enterprise, in the way of high-speed long-distance electrical railways. Short railways at 25 miles an hour or so have proved their utility, and the energies of man will not be bounded by present achievements. Rumours from various quarters have been rampant—from St. Petersburg and Vienna, among other places—with reference to large undertakings for railways of the newer sort at speeds running up to 100 miles an hour, and now America has actually begun such a line. There is nothing impossible about such schemes; the problems are quite as much of a financial character as of a mechanical or electrical kind. America seems to be pointed out as the proper field for such experiments, and Chicago as the proper city. If only it could have been ready for the exhibition, the world would have been delighted. Direct from St. Louis to Chicago, across the prairie land, is the project, and Dr. Wellington Adams, who is the apostle of the "Through-by-Lightning" express, is pushing forward the matter with the utmost activity. We have just received a letter from Dr. Adams, in which he announces that "the contract for construction has been placed. The line, when completed, will be 250 miles in length, which is 30 miles shorter than the present shortest line between the two cities. Four great lines of steam railway now compete for the traffic between these western metropolises, which have a combined population of 1,700,000 people. The State of Illinois, through which the line is to run, is almost entirely a prairie state, and is filled with flourishing agricultural and manufacturing communities. There is very little grading necessary, and we believe that we have selected the most advantageous place in the United States to build the first long-distance electric railway." We have received at the same time the prospectus of the Chicago and St. Louis Electric Railroad Company, St. Louis, showing the tapernosed bogie passenger cars that are to be used for the 100 mile an hour service. Splendid termini are designed for immediate erection at St. Louis and Chicago. Two power-houses will be constructed at the company's own coal-mines. Alternate currents will be used, generated at 500 volts, transformed up to 50,000 and again down to 3,000 volts at the sections. The road will be divided into 25 sections of 10 miles each. The cars will run one section apart, and no current will flow in the intermediate section, so that it will be impossible for cars to come within 10 miles of each other, thus forming an absolute block system. Incandescent lamps will light up the track a mile ahead and behind each car at night. There will be no crossings or switches, waggon roads will pass over, and the railroad itself will pass over other railroads. Four tracks will eventually be laid, but only two at first. The cars weigh 15 tons each. The driving-wheels of the motor are 6ft. diameter, running at 500 revolutions on friction roller bearings. The company has secured a charter, the surveys are complete, and the line is now in course of construction. Electric light and power will be also distributed, making it one of the most important electrical enterprises yet undertaken. It is impossible not to admire the energy with which the daring project has been put in hand.

Goebel's Lamps.—Affidavits over Goebel's lamps in the Beacon Company injunction case are as thick as roses in June—and as differently coloured. We have no space to give the whole, but it is needless to say the sudden eruption on the scene of a lamp antedating Edison and Swan by years, and practically as perfect, has created the profoundest interest all round. Goebel's second affidavit states that it was before he removed in 1872 that he settled upon bamboo as the best material, and he made special instruments for dressing it, by which the strips were pulled through the instrument with pincers. Knew that platinum was the best wire, and almost always used it; a lamp (in horseshoe shape) has been in his possession since 1872, and has burnt it many times. Always used distilled mercury in a very dry atmosphere to get the vacuum. Tried platinum as the incandescent wire, but it melted; then tried carbon, which he knew from experience with arc lamps would not melt. Has received no consideration for his testimony and expects none; has no enmity towards Edison; knows no one connected with defendant company; and gives his evidence with reluctance and only on urging. Henry Goebel, jun., states that lamp No. 4 has been in their possession since 1872. Jas. Vandergrift states he has examined this lamp and finds it has a fair vacuum; the lamp might burn 100 to 200 hours. Franklin L. Pope states he had doubts about lamp No. 4, as he thought if the lamp had been filled with mercury some traces would have been visible on the copper wires which are there used. Goebel asserted that if distilled mercury were used the effect would not take place; tested the matter experimentally, and finds it true. Edward Cary, superintendent of defendant company, says he has considered the statement that lamps with iron or copper wires will not hold vacuum, has tried lately and finds they do, though the percentage of failure is greater than with platinum. David Hall, jeweller, says Goebel gave him a lamp prior to May, 1872; showed it his father, who died in 1873; places the utmost reliance on Goebel's statements; has seen him make bamboo strips with a jeweller's drawplate. Several affidavits on the other side were made. W. C. Dreyer states he negotiated with Goebel in 1882 for purchase of his invention. His failure to produce any old lamp and general unreliability and looseness of statement caused negotiations to be dropped. If Goebel had lamps it is certain he would have produced them; approached the Edison Company, and the matter was gone into by Mr. Dickerson and Major Eaton, and the conclusion was summed up by Mr. Dickerson thus: "Even if Goebel did what he claims, it is nothing but an abandoned experiment." W. McMahon remembers asking Goebel if he could show a lamp made prior to Edison's and his replying, with a laugh, "Well, we might make one that would look old"; believed Goebel was used as a tool, and that nothing was made prior to 1882. Timothy McMahon also visited Goebel's without seeing incandescent lamps, and remembered his saying he could make a lamp "look old.' Otto Moses stated he had heard of Goebel in 1884, called and asked to see lamps; Goebel asserted he had made lamps long ago, but had none to show. Albert Helschel, a glass-blower, said he had worked in 1881 with Goebel for months; found he knew very little about lamps, trying to make filaments out of paper, using a crude pump; Goebel had made four lamps with carbons from a Maxim lamp and hung them in his window, and never claimed to have made lamps earlier. Several persons affirmed that they had seen Goebel's telescope, and none of them had seen the electric lamps on the waggon Major Eaton stated that Henry Goebel, jun., had called on him in 1882 and offered the inventions for 20,000dol., but he had declined. The negative evidence, of course, does not disprove the positive, and the general opinion seems to be that the surprise at first affected is discounted by the fact that the Edison people were aware of Goebel's claims as early as 1882. If the restraining order is denied, a fight to the death will follow—as curious a sequel as any patent litigation in the world can show.

ELECTRICITY AT THE THEATRES.

The electrical industry owes much to what may be termed the go-aheadness of theatrical managers. They were amongst the earliest to utilise electricity for the purpose of lighting, and they have gradually been adding to the uses of electricity by adapting it in various forms in their scenic displays. One of the prettiest scenes which can at the present time be seen at any theatre is the Highgate-hill scene in Mr. Oscar Barrett's pantomime now being played at the Olympic. No sketch can adequately represent the beauty of the scene. Dick Whittington is supposed to be asleep, and the stars gradually come out into the clear sky. The arrangement has been made by the Lithanode and General Electric Company, and we understand that the design is due to the manager, Mr. J. T. Niblett. The stars are arranged to indicate various constellations, and are energised from secondary batteries made by this company. Mr. Bowles has endeavoured, in the accompanying picture, to give some idea of the scene as it appears, but it is difficult, as we say, to do justice to the scene. Besides the stars—the effect of which is obtained by the use of a large number of small incandescent lamps, some of which have a higher resistance than others, and therefore gleam more brilliantly — there are a number of fixed incandescent lamps at various points which the attendants make to twinkle. Not only from an electrical point of view, but from the spectacular point of view, the scene has proved very effective. We are glad to hear that Mr. Oscar Barrett's pantomime has been very successful. It is really one of the best entertainments now before the London public.

The Highgate-hill Scene in the "Dick Whittington" Pantomime at the Olympic Theatre.

We have also endeavoured to represent what may be termed the celebrated electrical dance recently acted at the Alhambra. We believe the suggestion was due to Mr. Fyfe, who has, as is well known, been for many years engaged in electrical work of one kind or another. Miss Navette was, if we may so term it, framed in a bouquet of flowers and incandescent lamps. These lamps were energised by contact being made with plates fixed at various points on the stage. Of course, as the dancer came to these points and made contact, the lamps were energised, became brilliant, and presented a very fine effect. Sometimes Miss Navette carried a garland of flowers with incandescent lamps in addition to this on her person; at other times a parasol, the ends of the ribs of which were crowned with incandescent lamps. Our artist has in his sketch obtained considerable assistance from a photograph taken by the Stereoscopic Company. Great credit is due to Mr. Fyfe for the admirable way in which he carried out this work.

Mr. Bowles, in the accompanying sketch, has endeavoured to depict another scene in which electricity plays a conspicuous part. The Alhambra boasts of this further use of electricity in the spectacle provided for the public in the ballet "Aladdin." The batteries and lamps for this scene have, we believe, been carried out under the auspices of the Lithanode Company, as at the Olympic. For spectacular effects we think it would be difficult to find a worthier representation than in this scene from the "Aladdin" ballet. Besides the scenes our artist has depicted, electricity is largely used for scenic effects at both the theatres mentioned. The Lithanode Company has at the Alhambra supplied eight of the chief dancers with 2½-c.p. lamps actuated by their three-cell lithanode accumulators. The principal dancer is fitted with a bright head-light. The ogre in the ballet is fitted up with eight 5-c.p. lamps on the tips of his wings. These lamps are run from a five-cell battery. Two 12-c.p. lamps, run from a six-cell battery, are placed behind lenses which form the ogre's eyes and made to flash, thus making a very effective ogre. The Alhambra is noted for its spectacular effects, and from a business point of view the trouble and expense taken to provide these scenic effects are amply warranted by the returns. It is well known to our readers that both the Alhambra and the Olympic are electrically lighted, each having its own nstallation. Another theatre where electricity has been most effectively used is Drury Lane, where in the pantomime is a scene in which a bold use is made of mirrors; in fact, the ballet is enclosed on three sides and above by mirrors, and by these, with incandescent lamps carefully arranged, a scenic display is obtained which it would be difficult to beat.

Miss Navette in "La Danse Electrique" at the Alhambra.

Scene at close of Aladdin Ballet at the Alhambra.

In another play recently produced in London—"To-day," at the Comedy Theatre—a somewhat important part was played by portable secondary batteries. The scene of the last act was laid in the supper-room of the Savoy Hotel, which in the original is lighted most artistically by means of electricity, and as Mr. Hawtrey was desirous of having as faithful a representation as possible, it was decided to light the scene by electric lamps with fittings similar to those in the hotel itself. That there was no electric lighting of any description in the theatre at all formed no barrier to the carrying out of this intention, as it was found that an ample supply of electric current could be obtained from a dozen portable accumulators, light enough in weight to be handled with little difficulty. This was, of course, a *sine quâ non*, as, having no supply of electricity in the building, it would consequently be necessary to remove the whole of the batteries from the theatre every time they required to be recharged. An installation of between 30 and 40 4-c.p. incandescent lamps were introduced into the scene, distributed as follows: Twelve bracket lamps on the walls, actuated by three six-cell secondary batteries; seven two-lamp table pedestals, placed on separate tables, and each actuated by a five-cell battery fixed under the table itself; and eight lamps for illuminating flower-stands, arranged in two sets of four lamps, each set placed upon a separate table, and actuated by a five-cell battery. The scene lasted about 40 minutes, and it was found that by charging the batteries, which were of the lithanode type, twice a week all the light desirable was obtained. The heaviest of the batteries weighed about 35lb. with elements and liquid complete, so that they could all be transported without difficulty between the theatre and the Lithanode Company's works, about one mile distant, where they were taken to be recharged. The effect of this installation was very pleasing, as the scene was lighted up in such a way as perhaps no other form of artificial illumination could have done. It was also interesting as an example of what could be accomplished in the way of stage effects, by means of well-appointed secondary batteries alone, in a theatre where no supply of electric current was available.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 174.)

(*a*) *Alternating Currents.*—The armature will be limited to a single coil in order to explain the action more easily. Imagine this coil occupies a vertical position, the lines of force threading through it at right angles. Let the coil be moved counter clockwise through an angle of 90deg., or a quarter of a revolution. Just at the point of starting, the coil will move almost parallel along the lines, and so the rate of cutting will be at the lowest, whilst when the coil is at right angles to its first position the rate of cutting will be at the greatest, because the coil is moving at right angles to the lines, and so will cut right down and through them. During the second quarter revolution, the rate of cutting will decrease, until on completing one half a revolution, or 180deg., the coil will again slide along the lines, and so will do no cutting, as happened at the starting. The other half revolution the same thing is repeated, but with this important change: the first half revolution the coil travelled in a downward direction, and in the second half it will travel in an upward direction.

The number of lines of force cut per second determine the value of the E.M.F. set up in the armature coil, and the number cut in one complete revolution will vary from a minimum to a maximum, then to a minimum, then to a maximum, and then to a minimum again; therefore it follows that the E.M.F. set up will rise and fall in a similar way. The direction in which the E.M.F. acts depends on whether the lines of force are cut by a wire having a downward motion, or by one having an upward motion. This being so, the E.M.F. acts in one direction during the first half revolution, and in the opposite direction during the second half; as the current produced depends on the E.M.F., therefore we have a rise and fall of current with the current flowing in one direction, and then another rise and fall of current with the current flowing in the opposite direction.

The first quarter revolution, from vertical position of 0deg. to 90deg., the current rises from zero to a maximum value; during the second quarter, from 90deg. to 180deg., the current falls to zero; during the third quarter, from 180deg. to 270deg., the current again rises from zero to a maximum; and during the last, or fourth, quarter from 270deg. to 360deg., it again falls to zero. The above forms a cycle, which is graphically illustrated by the top curve in Fig. 17, where the horizontal values refer to the angles of rotation, or position of the coil, and the vertical values give the E.M.F. at those positions. That part of the curve above the horizontal axis denotes one direction of the current, say, that arising from the first half revolution, say, the positive direction, while the part below denotes the other or negative direction, produced by the second half revolution. The two ends of the armature coil are attached to two brass rings, one to each, insulated from one another, and fixed on the armature shaft. On each ring a brush rests, and as they revolve with the armature the brushes make a sliding contact and so conduct the current into the external circuit, to the lamps or wherever else it is required, the current leaving by one brush and then returning by the other.

It is usual to express the horizontal values of the above curves in fractions of seconds of time, for suppose one complete revolution is made in the time ·1 of a second, then the distance T_0 T_1 represents ·1 of a second, because the whole curve is the result of one revolution. The E.M.F., therefore, at the commencement, or at time 0, is 0, at ·025 of a second it is at a maximum, so that it takes ·025 of a second to grow from nothing to its full strength. The distance T_0 T_1 measures what is technically named the "periodic time," or the length of time that is occupied to enable the E.M.F. to rise and fall, first in a positive and then in a negative direction. This cycle of fluctuations limited by T_0 T_1 is termed an "alternation"; hence, in a machine having only two magnetic poles, there can only be one alternation per revolution, which is the case shown by Fig. 17, and assuming that the armature revolves at 600 revolutions per minute, this will give us 10 alternations per second, because it makes 10 revolutions per second. If the machine had four poles, then the current would have two alternations per revolution, and hence with the above speed 20 alternations per second. And however many poles the machine may have, the number of alternations per second, or its "periodicity," is obtained by multiplying the number of revolutions per second by half the number of poles.

It must be well understood that an alternation does not mean a mere reversal in direction, say, when passing from a north pole to a south pole; what it does signify is a complete cycle, consisting of a positive wave and a negative wave, so that the top curve in Fig. 17 represents one alternation, as explained above. The symbol used to express this cycle is ⌒‿, being a diminutive curve. It may be observed that the E.M.F. curve of Fig. 17 represents a curve of sines. Now it has been found by careful experiments that the values of the E.M.F. of a revolving coil rise and fall very nearly in the same way as the sine of the angle which the coil has in its various positions. For example, when the coil is perfectly vertical it is at 0deg. or 360deg., and it is moving almost parallel with the magnetic lines, consequently the E.M.F. is at zero, and the sine of 0deg. or 360deg. is zero also; when at an angle of 45deg., or halfway between vertical and horizontal positions, its value will be found to be proportional to the sine of 45deg., which is $\sqrt{\frac{1}{2}}$ or ·7; coming to 90deg., or the horizontal position, its value will be proportional to the sine of 90deg., which is 1, and all intermediate values are also nearly in proportion. To simplify calculations it is customary to consider the curve as a curve of sines, and for most practical work this answers well enough.

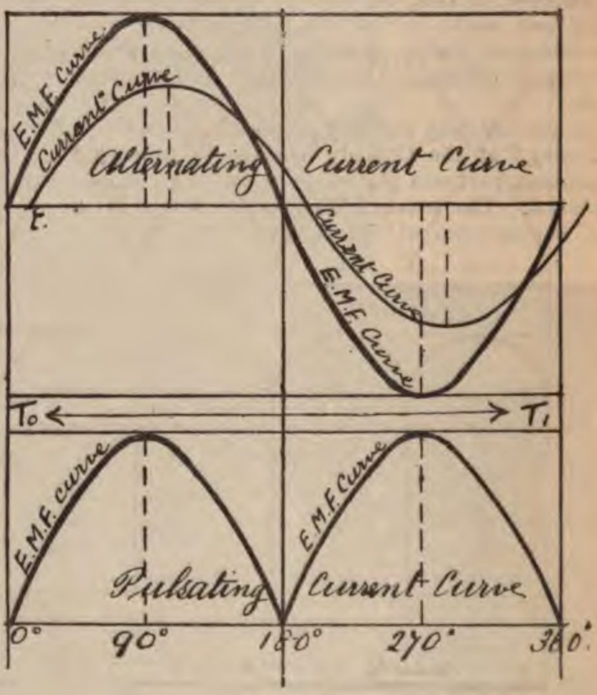

FIG. 17.

The rise and fall of the current depends on the rise and fall of the E.M.F., but alternating currents are somewhat analogous to the increase and decrease of magnetic induction when a magneto-motive force makes a magnetic cycle. It will be remembered that the induction, B, lagged behind the magneto-motive force, H (see Fig. 14), and putting E.M.F. for H, and current for B, we have a similar lagging of the current behind the E.M.F. in alternating currents, so we may draw a second curve for the current which commences a short time after the curve of E.M.F.; the current wave thus lags behind the E.M.F. wave. This lagging is named a "retardation in phase," and when two waves, such as the two waves of E.M.F., of two machines, coincide with each other, they are said to be "in phase," and when one wave lags behind the other it is "out of phase."

For continuous currents, Ohm's law of the form $C = \frac{E}{R}$ holds good, but in alternating currents, although Ohm's law holds good just the same, yet it must be written in a more complex form, because the E.M.F. is constantly changing in value and direction, same with the current; this gives rise to certain important effects, which will be discussed when treating of Ohm's law for alternating currents. For the present, it suffices to say that these effects cause a decrease of the current, hence the current waves are drawn smaller in amplitude than the E.M.F. waves; these opposing effects act as if the copper conductors of the circuit had more resistance than what they really had, and so cause a smaller current to flow. The distance $T_0\ t_1$ marks the "retardation in phase" between the E.M.F. wave and the current wave.

(*b*) *Pulsating Currents.*—A pulsating current signifies one which flows always in the same direction, but which rises and falls in value, increasing from zero to a maximum and then dropping to zero again. This action is easily obtained by what is called "commutating" the alternating current. To effect this, instead of joining the two ends of the armature coil to two separate collecting rings, they are connected to a split tube or ring, so that one end of the armature coil is fixed to one semicircle of the tube and the other end of the armature coil to the other semicircle. The two halves being insulated from one another, the brushes are placed diametrically opposite each other on this split tube, in such a position that when a reversal of direction of current is about to take place the brushes change halves by breaking contact with one half of the tube and making contact with the other half, so that at the moment of reversal of flow the brushes likewise make a reversal of contact, by passing from one portion of the tube to the other. In this way the brushes lead off a current which is commutated in one direction. The split tube is called a "commutator."

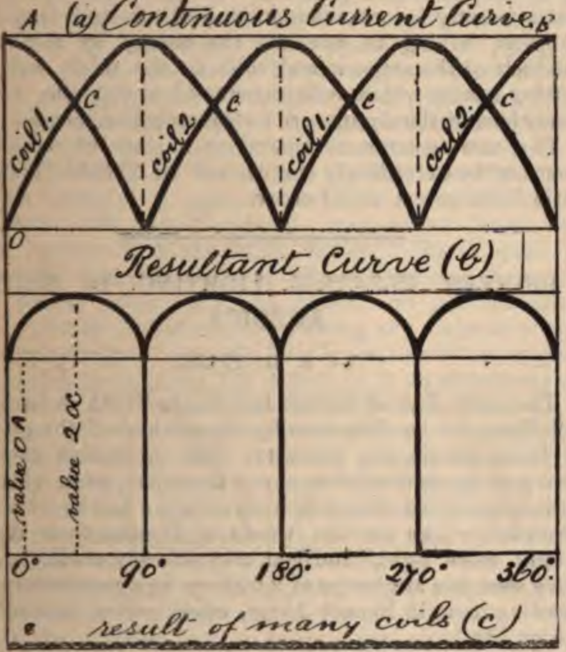

FIG. 18.

The bottom curve of Fig. 17 shows, graphically, the nature of a pulsating current, both waves of the curve being now above the horizontal axis, thus indicating the same direction.

(*c*) *Continuous Currents.*—If incandescent or arc lamps were run with a pulsating current derived from one coil, the light would fluctuate up and down, on account of the rising and falling of the current; but by using a number of coils in the armature arranged so that one set comes into action just as another goes out, the curves obtained would overlap one another, and so the crests of the wave-curves would be very close together, and form a wavy line whose resultant crests and hollows would be so small that it would practically amount to a straight line. This effect is shown in Fig. 18. This can easily be traced, for suppose there were two coils, one being fixed at right angles to the other, then when No. 1 would be vertical, or in the position of least activity, No. 2 would be horizontal, or in the position of greatest activity, as shown by the two top curves of Fig. 18; and the two waves cross each other at an angle of 45deg., which signifies that when No. 1 coil is half-way between vertical and horizontal positions, and decreasing in value, No. 2 coil is similarly situated, but increasing in value. This is the relative position of the two coils towards each other. Now let us examine what the resultant E.M.F. wave as obtained at the brush points will be. It is evident that the maximum E.M.F. of either coil alone at the two brushes is that given by the crest of either wave, so we can draw a line, A B, along the top of all the crests, and this line indicates the minimum resultant E.M.F. at the brushes. Now the lowest point reached is fixed by the crossing of the waves, but at these crossing points, C, the E.M.F. of the two coils are equal, consequently the total E.M.F. due to both coils must be double the height of these points, O C, and this is the resultant maximum at the brushes. Intermediate values can be obtained by adding together the vertical values of the two curves at every instant. These integrated values are then plotted again and give the resultant curve, *b*. Hence the resultant E.M.F. at the brushes fluctuates between the two values, O A and 2 O C. By increasing the number of coils to four, we get a resultant curve whose fluctuations are more limited, and using more coils we can reduce the fluctuation so that it resembles a wavy line, as shown by *c*.

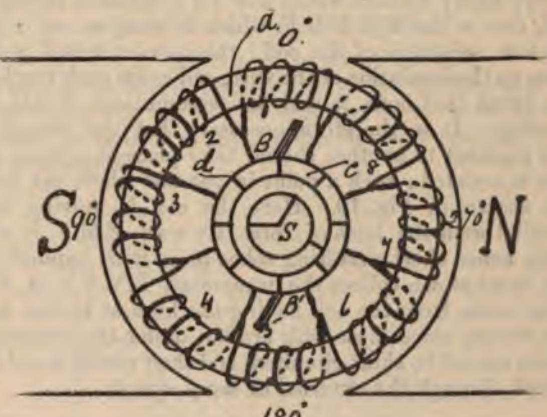

FIG. 19.

The commutator which was used for leading off the pulsating current must now be supplanted with one divided up into a number of parts. In addition to this multiplicity of coils, all the coils are joined up in series, so that the end of one is joined to the beginning of the next and so on. The beginning of each coil, and therefore the end of the next coil, are connected to one part or "segment" of the commutator, as is clearly shown in Fig. 19, similar numbers referring to each coil and its proper segment. In this figure, *s* signifies the driving shaft; *c* the commutator, divided into segments by insulation denoted by thick lines; *a* the armature core, upon which are wound the eight coils; S and N signifying the south and north pole-pieces of the field magnets, the rotation of the armature being counter clockwise, or against the sun. The leading-off wires from the two brushes, B and B^1, are not shown in order to make the diagram clearer.

Now, the E.M.F. set up in each individual coil depends on the position which that coil occupies in the magnetic field. No. 1, for example, lies at the top, parallel to the lines of force, consequently at this point its rate of cutting will be at zero, or a minimum; No. 2 is 45deg. further on, and its rate will be higher; while No. 3 lies at right angles to the lines of force, and its E.M.F. will therefore be at a maximum, because it is making a straight downward motion across the lines. The same argument applies to all the rest. The effect of all the coils being joined up in series is that the E.M.F.'s of all lying between 0deg. and 180deg., or on one half of the armature (Nos. 1, 2, 3, 4), will be added together.

In a similar way the E.M.F.'s of all the coils of the other half (Nos. 5, 6, 7, 8) will be added together, but the coils belonging to the first half are in parallel with the coils belonging to the second half, because they form two paths between the two brushes, B and B^1. The sum of all the E.M.F.'s of the first half is equal to the sum of all the E.M.F.'s of the second half, and this is the same thing as there being only one E.M.F., and each half has the same resistance and is in parallel; consequently the resistance between B and B^1 is one half the resistance of the sum of the resistances of either half, or equal to one quarter of the resistance of all the coils counted all round the ring.

Upon examining Fig. 19 carefully, it will be seen that the brushes are made so broad that they touch across two segments of the commutator. This is done in order that they shall make contact with one segment before they leave the others, and so not cause any break in the circuit in changing over; the result of this is to complete the circuit of the coil that happens to have its ends on these two segments. This is called "short-circuiting" the coil. Now it is evident that if the coil were short-circuited by a brush when that coil was in the position that No. 3 coil occupies in Fig. 19 (or the position of greatest "activity," as it is called), a very heavy current would flow for a moment through the coil, due to the high E.M.F. which is being set up in it and the low resistance of the coil; this current would probably burn up the insulation of the wire, and cause such sparking at the brush that both it and the commutator would suffer terribly. It is therefore necessary that the change from one segment to another should take place at a point where this is avoided; such a point is the one where the brushes are shown in Fig. 19. Here the coil is moving mostly parallel with the lines of force, its own E.M.F. is almost zero, hence short-circuiting takes place with impunity, and the brushes can collect the integrated E.M.F.'s of all the other coils, from the coil having the highest to that having the lowest, since these coils are not under the brushes, and hence cannot be short-circuited, and their circuit is only completed through the external or lamp circuit.

(To be continued.)

LORD KELVIN'S NEW ENGINE-ROOM WATTMETER.

At one of Dr. Fleming's Cantor lectures recently delivered in the lecture-room of the Society of Arts, London, was shown for the first time Lord Kelvin's new engine-room wattmeter.

This new energy-measuring instrument is exceedingly simple in construction, and merely consists of one fixed coil and two movable coils. The fixed coil is shaped somewhat after the fashion of the figure 8, and is fixed to a slate base-board; thus very high insulation is obtained. The two movable "potential" coils are artistically arranged, and are supported by suitable means from the slate base-board. These potential or shunt coils are wound with a large quantity of fine wire, and are fixed together on an aluminium frame which is supported on a novel system of knife-edges, which has the advantage of always having a constant bearing point without any appreciable frictional error.

A small current is conducted into and out of the shunt coils by means of two flat spiral springs, made of some non-magnetisable metal. These springs are made up much in the same way as the escapement of a watch. The main fixed coil is so constructed that it will readily carry currents of from two to three hundred amperes. In series with the shunt coils is placed a non-inductive resistance so placed that it cannot induce currents in any part of the instrument. The amount of added anti-inductive resistance naturally depends upon the E.M.F. of the circuit. In the instrument shown, the added resistance was approximately 20,000 ohms. The instrument scale is graduated to read directly in terms of watts.

The chief characteristic of the new instrument appears to be the astatic arrangement of the shunt coils, which should render them quite free from any external disturbances whatever, and the new means of suspending the movable coils so as to enable the readings to be taken from a vertical scale.

The instrument is constructed mainly for use on alternating-current systems where it is desirable to know the true number of watts developed and used. There can be no doubt that in the future instruments made on the wattmeter plan will be used instead of ampere-meters in all alternating-current systems, owing to the fact that the product of the current into the volts does not show the true energy given out on an inductive alternating circuit. This feature of induced or alternating currents is, of course, well known, but it has been much emphasised in Dr. Fleming's lectures.

By the employment of this instrument the true amount of electrical energy as generated by an alternating machine may of course be read off quite accurately. This is an advantage which will be much appreciated by engineers in charge of central or other alternating-current stations, who, by the use of this instrument, would always have the true watts directly before them, instead of, as now frequently happens, having to calculate the energy by taking the products of the amperes and volts in the usual way, and getting results which, unless corrected to suit the varying conditions of the circuit, are in themselves erroneous.

The new instrument viewed as a piece of mechanism seems to be exceedingly simple, and we should think but little liable to get out of order.

PIONEER ELECTRIC LIGHTING IN SOUTH AMERICA.

BY E. H. TYLER.

The early days of electric lighting in South America are not likely to be forgotten by those who had the privilege of being among the pioneers. The Argentine Republic, owing to the benevolence of our financiers, were then able to indulge in luxuries which we at home had to wait many years for. Like the last words of Goethe, their cry was "light, more light," and you may scarcely credit it, but I have seen five arc lamps of 2,000 c.p. in a moderately-large drawing-room in Buenos Ayres, whose owner wished to be "high life."

Generally the lighting was all arc and multiple-series groups. The latter were frequently the cause of a flare-up, as the South American is a born electrician, and soon discovered that by removing one lamp and inserting a piece of paper in the cut-out he got a more brilliant illumination—alas, all too ephemeral! The mains were all overhead, gracefully festooned from palm posts on telephone insulators, and we never worried much about earths. At this time we were operating some 250 Brush arc lamps and about 50 groups. Our linesmen and carbon-trimmers were all Italians and Gauchos, rather thick-headed and dangerously hot-tempered, but I never had to discharge one for drunkenness. I wish I could say as much for the English workmen in South America. I was engaged on the erection of the first high-tension station in South America, which was indeed one of the first of the kind anywhere. It was in a town at the foot of the Andes. The engineer in charge is now assistant engineer to one of the big London supply companies. The voltage was 2,000 volts, and the mains were Callender's hard-drawn, low-insulation. The insulators were ordinary bell-shaped, happily now obsolete for this class of work. The terrible experience of our first month's running I shall never forget. We killed three or four boys, and our breakdowns were of the most frequent recurrence. The Governor of the province remarked to me, *apropos* of the boys being killed, "A good thing too; that will keep the others off." There was no inquest, and indeed I never was able to ascertain the real number of people injured. Those were indeed halcyon days! The Governor was a very good type of the usual South American tyrant. I am glad to say that quite recently he has been kicked out by his long-suffering victims, and barely escaped with his life in the revolution which took place. If his lights went out he used to send and threaten to have us all locked up, by no means a laughing matter to those who know the horrors of an Argentine prison. I know, because I have been imprisoned on and off no less than eight times for crimes of varying atrocity, including running to catch a tramcar, and for being a moving target during revolver practice. I may here say that an electrical engineer enjoys unusual advantages of getting a real insight into the ways and customs of the people. He has the "open sesame" to almost every house, private and public, and many are the humorous and tragic scenes I have witnessed while "trouble-seeking" on the roofs of a South American town. I remember on one occasion the only way to the roof lay through the bedroom of the senorita, and I was told it was impossible to pass. Those who know the extreme punctiliousness of the Spaniard will, I hope, give me all credit when I say I persuaded her to put her charming head under the clothes while I went through the roof like the clown in a pantomime. The dangers of trouble-seeking, by the way, were not all electrical. On more than one occasion I have been fired at, and then received profuse apologies on the ground that my friend thought I was a burglar. Knowing how dearly loved the "Gringo Ingles" is in South America, I had my own opinion as to the sincerity of the apology.

With all its drawbacks, however, the Argentine is a happy hunting-ground for the electrical engineer. He is not pestered and hampered by grandmotherly Board of Trade or insurance restrictions, and when mounted on his sturdy half-bred he dashes off through the wind, rain, and darkness of a pampero to find a broken circuit, he pities his less fortunate brothers at home who "sit poring over miserable books." Brazil does not offer the same excitement. The Brazilian is a kind and affable being, slow to anger, and not pretending to understand electricity, nor showing any desire to acquire such knowledge. Certainly I did know a Brazilian engineer who tried to calculate the output of a dynamo from the number of the machine—I think it was 1,565—and the formula A10 (the machine was a Mordey alternator). I left him before he had finished. A great many of the central stations there are actuated by water power. The works necessary to make a really good job of water power entail very costly embankments, sluices, etc., which at first sight seem superfluous, hence the work is often cheaply done and troubles ensue. The terrific tropical storms sometimes swell a river several feet in as many minutes, while the rubbish that is swept down clogs the gratings and sometimes the turbines. When it comes to keeping a block and tackle over the first grating to haul away the dead mules that accumulate, some slight idea of the difficulties may be understood. The easy-going Brazilian inspector, however, does not much mind a trifle like a few hours' shut down. If you explain to him that you had to stop to remove a bullock's horns from the nozzle of the Pelton wheel, he "begs you not to mention it; these little accidents will happen."

In spite, however, of a departure from the usual English practice and the unskilled labour they have to employ, the South American stations are most creditably served. Their engineers have graduated in the hard school of experience, and have acquired by sheer necessity that readiness of resource which makes them useful and practical men.

HOW TO DESIGN A SMALL MOTOR.

BY E. MEYLAN.*

Every designer of dynamos worthy of the name is in possession of methods and practical results which enable him without difficulty to design a dynamo or motor for any given purpose, on condition that he does not pass too far from ordinary types and classic arrangements. It is, however, not the same with a large number of electricians and amateurs, at least if we may judge from the demands for instruction which are constantly reaching the technical papers, and we shall not be wrong in supposing that trials of this nature must lead to numerous disappointments.

It will probably be rendering a service to enquirers of this kind to give in full two examples of the complete working out of the elements of a small motor of $\frac{1}{8}$ h.p. (10 kilogrammetres per second). We take two different types—one motor with Gramme ring armature, and the other with a Siemens drum armature. We shall not insist in this description upon the practical point of view, or the most economic conditions of construction. Average data will be taken—in one of the cases the dimensions indicated in part by a correspondent requiring information will be taken, while in the other conditions have been sought more favourable from a practical point of view.

As intended, both motors will be practical machines, giving the results indicated within reasonable limits. There should, of course, also be a practical study of the details of arrangement, and a careful discussion of the question of metals to be employed—iron, cast or wrought, steel, or other metal to be used in the various parts—as well as the manner of arranging the joints in order to obtain an easy, strong, and economical assembling of parts. This is the business of a dynamo builder who looks at the matter from the point of view of profits to be made, and who wishes, also, if he has any proper pride, to design a machine embodying some originality. We shall, however, here content ourselves with the calculations alone, showing what conditions must be satisfied to obtain the results desired.

1. *A Gramme Motor of $\frac{1}{8}$ h.p.*

It is required to build a series motor which at 100 volts will supply an effective power of 10 kilogrammetres per second ($\frac{1}{8}$ h.p.) at a speed of 3,000 revolutions a minute. The type to be used is that of the two-pole inverted fields shown in Fig. 1.

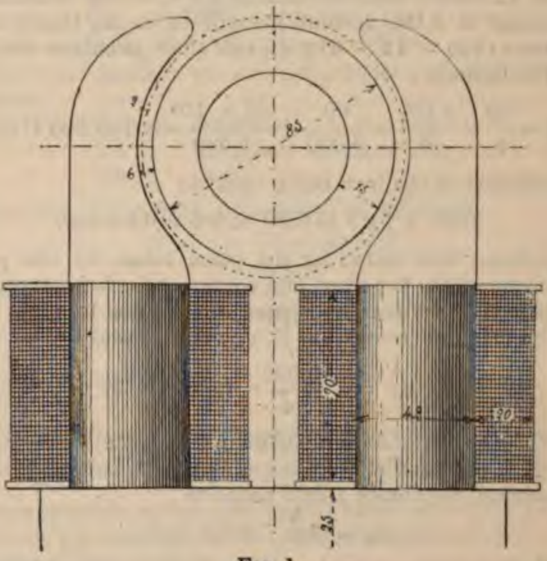

FIG. 1.

We do not begin with general formulæ by which to determine the dimensions beforehand. These formulæ are good only for professors who never have to apply them. With a little experience the designer of dynamos should arrive at an approximate idea of dimensions. A first scheme is worked out to see if the conditions are realisable. This is modified as many times as is necessary till a result is achieved which will satisfy all the conditions given. We shall only give here the result of the last calculation.

We shall take for this motor a commercial efficiency of 60 per cent., which we shall justify by final results, at the same time showing in summing up that the results found cannot with advantage be departed from too far.

The electrical data would therefore be: Volts at terminals, 100; power absorbed (each kilogramme per second being 9·8 watts), $10 \times 9{\cdot}8 \div 0{\cdot}60 = 164$ watts, or, in round numbers, 170 watts. The current will therefore be 170 $\div 100 = 1{\cdot}7$ amperes.

Size allowed for the iron core of armature: Exterior diameter, $D = 8{\cdot}5$ cm.; interior diameter, $d = 5{\cdot}5$ cm.;

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* Translated from *L'Electricien*, December 3, 1892.

whence thickness, a, along radius $= 1{\cdot}5$ cm.; length along axis, $b = 6$ cm.; number of turns of wire, $N = 1{,}500$, which may be divided into 30 sections with 30 commutator segments.

The calculation of the resistance of this armature—as well as the condition that the air gap should be reduced as much as possible so as not to need too great an intensity of field—has led to the choice of wires of 6 mm. diameter which, with insulation, will occupy a square of 7 × 7 mm.

The mean diameter being about 8·9 cm., we have a mean development of $8{\cdot}9 \times 3{\cdot}14 = 280$ mm.; we can therefore wind $280 \div 0{\cdot}7 = 400$ turns per layer, and with four layers we can easily wind 1,500 turns.

The average length of a turn being equal to $2\ (6 + 1{\cdot}7) = 16$ cm., we shall have a total length of 240 metres of wire of 0·6 mm., the resistance of which would be about 14 ohms. The resistance of our armature will, therefore, be equal to $14 \div 4 = 3{\cdot}5$ ohms.

The loss of voltage $r_a\, i = 3{\cdot}5 \times 1{\cdot}7 = 6$ volts; the loss of power $r_a\, i^2 = 6 \times 1{\cdot}7 = 10$ watts.

The surface of the armature being equal to about 2·5 decimetres square, this corresponds to a radiation of four watts per decimetre square, a value perfectly allowable and even low.

The length of the total air gap, C, between iron and iron will be divided as follows:

Insulation	0·5 mm.
Four layers of wire: 4 × 0·7	3·0 „
Play, including space taken by binding wire	2·5 „
Total	6·0 mm.

The useful magnetic flux which must pass through the core would be determined if we knew the loss of voltage produced by the resistance of the field coils. A first calculation showed us that these losses would be somewhere about 12 volts; the counter E.M.F., e, of the armature at the speed of 3,000 revolutions will be equal, therefore, to 82 volts (100 – 12 – 6); we can then calculate the flux by the formula:

$$F = \frac{60}{n} \times \frac{e\, 10^8}{N} = \frac{60}{3{,}000} \times \frac{82 \times 10^8}{1{,}500} = 110{,}000 \text{ C.G.S.}$$

The section of the iron being equal to

$$0{\cdot}80 \times 2\, a\, b = 0{\cdot}80 \times 3{\cdot}6 = 14{\cdot}4 \text{ cm}^2.$$

(The factor 0·80 allows for the place taken by the paper which separates the discs, and corresponds, for instance, to sheet iron of 0·5 mm. and paper of 0·12 mm.).

The magnetic induction, $B_a\, y$, will be equal to

$$B_a = \frac{110{,}000}{14{\cdot}4} = 7{,}700 \text{ C.G.S.}$$

With the pole-pieces indicated in Fig. 1, and in the profile of which the possibility of slipping on the bobbins must be considered, we obtain a field equal to

$$S_e = 9 + 7 = 63 \text{ cm}^2.$$

We have taken as surface that which corresponds to the normal projection of the ends of the pole-pieces, adding on both sides an edge of 5 mm. to take into account the stray lines of force which are nevertheless drawn in by the armature core.

The true intensity of the field will therefore be

$$\text{True H} = \frac{110{,}000}{63} = 1{,}750 \text{ C.G.S};$$

$$\text{Mean H} = \frac{F}{\frac{\pi}{2}(D + c)\, b} = 1{,}300.$$

We are now able to calculate the excitation (after a first approximation to enable us to fix somewhere about the length of the cores) whence we can fix the values of the magnetic induction in the two field-magnet cores and the yoke.

We will allow 10,000 for these two, supposing that the magnetic circuit, entirely in soft iron, is formed of a rectangular yoke and two circular cores, whose prolongation forms the pole-pieces, Fig. 1.

If we allow a magnetic leakage of 20 per cent., we shall have to determine the sections of iron used:

$$S_{\text{yoke}} = \frac{1{\cdot}20 \times 110{,}000}{10{,}000} = 13{\cdot}2 = (7 \text{ cm.} \times 2 \text{ cm.})$$

$$\text{and } S_{\text{core}} = \frac{1{\cdot}20 \times 110{,}000}{10{,}000} = 13{\cdot}2 = (d_n = 4{\cdot}2 \text{ cm.})$$

We will admit for the magnetic properties of iron, the mean taken from the curves and figures given by Ewing and Hopkinson:

$$\text{For } B = 10{,}000 \quad H_{\text{iron}} = 8 \text{ C.G.S.}$$
$$\text{For } B = 7{,}700 \quad H_{\text{iron}} = 4{\cdot}5 \text{ „}$$

Estimating the length of the lines of force on the whole of the magnetic circuit as 30 cm. and in the armature as 8 cm., we shall have, in order to determine the excitation, the relation:

$$4\,\pi\, n'\, i = \Sigma\, H\, l \text{ in C.G.S,}$$

which gives for excitation in ampere-turns:

$$n\, i'_{a-t} = \frac{1}{1{\cdot}25}\left[\overset{\text{Air gap.}}{\underbrace{2 \times 0{\cdot}6 \times 1750}_{2{,}100}} + \overset{\text{Fields and yoke armature.}}{\underbrace{(30 \times 7) + (8 \times 4{\cdot}5)}_{250}}\right] = 1900$$

It is still necessary to take into account the reaction of the armature, which we estimate at 300 ampere-turns, or 16 per cent. of the true excitation.* It is therefore necessary to obtain a total of 2,200 ampere-turns, which with 1·7 amperes means 1,300 turns. As we have two coils in one magnetic circuit we shall require 650 turns on each coil.

With wire of 0·9 mm. diameter (1 mm. with covering) this would lead us to make the coils 70 mm. long, with a thickness of wire of 19 mm.

The average coil being 62 mm. diameter, the total length of the wire would be 260 metres, which corresponds with a field-magnet resistance $r_{fm} = 6{\cdot}5$ ohms.

Loss of volts: $r_{fm}\, i = 6{\cdot}5 \times 1{\cdot}7 = 11$ volts.

Loss of power: $r_{fm}\, i^2 = 11 \times 1{\cdot}7 = 19$ watts (5·5 W per dm²).

The total loss of volts due to the resistance of the motor is therefore equal to 17 volts (6 + 11), while we have allowed 18; the speed would simply be decreased by a little over 1 per cent., and it would be useless to make another calculation.

We can now calculate the loss of power due to hysteresis and to Foucault currents in the iron armature core; we will admit the formula of Steinmetz: $T = \eta\, B^{1{\cdot}6}$, taking as η a high coefficient, 0·004, which corresponds with moderately good and relatively thick iron discs.

The work per cycle and per centimetre cube is thus

$$T = \frac{4}{1{,}000} + 7{,}700^{1{\cdot}6} = 6{,}400 \text{ ergs.}$$

As we have 50 cycles per second and 155 cm.³ of iron in our armature core, it follows that the power loss under this head will be

$$W_{\text{hyst.}} = \frac{6{,}400 \times 155 \times 50}{10^7} = 5 \text{ watts.}$$

Summing up, we see that out of the 170 watts supplied to the motor we lose

19 in the field magnets,
10 in the armature,
5 in the core.

A total of 34 watts lost.

There remains 136 watts effectively transformed in mechanical work at the axle, or 13·8 kilogrammetres per second.

There remains, therefore, a margin of 3·8 kilogrammetres per second, or 27·5 per cent. for friction losses at the bearings and brushes, which certainly exceeds the

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* This reaction is that which corresponds to a lead of 20deg. $(\pi \div 9)$ of the brushes. The counter E.M F. due to the armature after shifting of the brushes is equal to

$$4\,\pi\, N\, i\, \lambda = 4 \times 1500 \times 0{\cdot}17 \times 0{\cdot}35 = 355 \text{ C.G.S.,}$$

or in ampere-turns: $\frac{10}{4\,\pi} 355 = 280$ (roughly 300.)

truth.* We may therefore expect to obtain something over 60 per cent. efficiency, or a little over 10 kilogram-metres per second effective (1 kg. = 2·2lb., and 1 metre = 3·3ft.; 10 kgm. per second thus = 22 × 3·3 × 60 = 4,356 foot-pounds, and divided by 33,000 = ⅛ h.p. effective).

The section, Fig. 1, represents this motor giving sizes: we remember that the width of the ring is 6 cm., and the width of the pole-pieces and yoke 7 cm. The weight of wire on the armature will be equal to 0·6 kilogramme, and that of the field magnets 1·6 kilogrammes, or a total of 2·2 kilos of copper wire.

We may now usefully discuss the dimensions given, starting from the speed of 3,000 revolutions.

It may be said first of all that it is difficult to reduce the size of the ring very much; indeed, to do this we should have either to increase the intensity of the magnetic field, or increase the number of armature coils, and consequently the amount of air space. These two modifications would necessitate an increase of excitation; now, our coils already occupy nearly the whole of the space at disposal (they would touch if the diameter of the ring were reduced); it would then be necessary to extend the cores and the encumberment would be increased in this direction. All that we could usefully do to this end would be to increase the arc embraced by the pole-pieces, but we must then renounce the desirable arrangement of being able to slip the coils over the top of the pole-pieces.

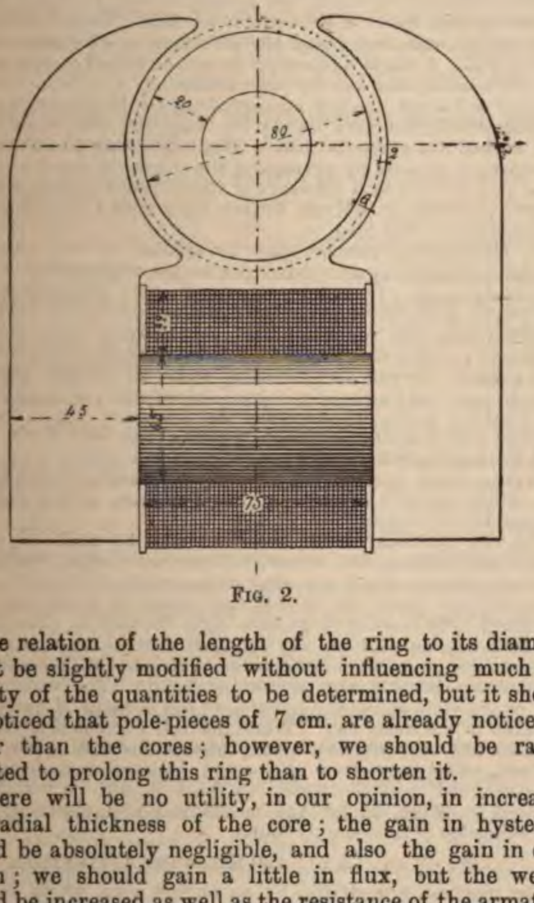

Fig. 2.

The relation of the length of the ring to its diameter might be slightly modified without influencing much the totality of the quantities to be determined, but it should be noticed that pole-pieces of 7 cm. are already noticeably larger than the cores; however, we should be rather tempted to prolong this ring than to shorten it.

There will be no utility, in our opinion, in increasing the radial thickness of the core; the gain in hysteresis would be absolutely negligible, and also the gain in excitation; we should gain a little in flux, but the weight would be increased as well as the resistance of the armature.

As to the wire on the armature, the loss of 6 volts is low; if we increase the diameter we should gain little—1 or 2 watts possibly—while each millimetre of air space represents an increased excitation of 140 ampere-turns or 3·6 watts under the conditions given, taking into account the fact that the exterior turns on the coil are much longer than the mean turn.

The diameter of the field-magnet wire, on the other hand, might be slightly increased to diminish the expense, as we have still space to spare. If it were required by one means or another to increase the efficiency, we might prolong the cores and increase the mass of wire, but only to a limited extent.

The speed of 3,000 revolutions a minute taken is that given by a correspondent; it is rather high, and would not be always admissible. If necessary to diminish it, still keeping the same general type of motor, all the dimensions would have to be increased. We shall see that with a Siemens winding and a magnetic yoke with one coil only we can obtain better results from the point of view of speed, and also of the number of necessary turns, both for the armature as for the field magnet, with practically exactly the same weight of wire.

2. *Drum-Armature Motor.*

A calculation of the same kind as that given led us to choose the dimensions indicated on Fig. 2; for this second example we will simply give the results obtained. We take as data an angular velocity:

n = 2,000 revolutions a minute.
N = 900 turns of wire 0·5 mm. diameter.

$$\left.\begin{array}{l} D = 8 \text{ cm.} \\ d = 4 \text{ cm.} \\ b = 7 \text{ cm.} \\ a = 2 \text{ cm.} \end{array}\right\} S_{\text{iron}} = 0{\cdot}8 \times 2 \times 2 \times 7 = 22 \text{ cm}^2.$$

Counter E.M.F.: $e = 80$ volts; $i = 1{\cdot}7$ amperes; $\eta = 60$ per cent.

$$\text{F} = \frac{30}{n} \times \frac{e \times 10^8}{\text{N}} = \frac{30}{2{,}000} \times \frac{80 \times 10^8}{900} = 134{,}000.$$

$$\text{B}_a = \frac{134{,}000}{22} = 6{,}100.$$

We will suppose, for the field magnet, a core of soft iron with two pole-pieces of cast iron. We take

$$\text{B}_{m\,\text{iron}} = 9{,}000;\ \text{S}_{\text{iron}} = 18 \text{ cm.}^2;\ d_n = 4{\cdot}5 \text{ cm.};$$

and $\text{B}_{\text{poles}} = 4{,}500$; $\text{S}_{\text{cast iron}} = 36 \text{ cm.}^2 = 8 \times 4{\cdot}5$ cm.

The magnetising forces corresponding are:

for $\text{B}_a = 6{,}100$; $\text{H}_{\text{iron}} = 4$ C.G.S.
$\text{B}_m = 9{,}000$; $\text{H}_{\text{iron}} = 6$ „
$\text{B}_{\text{poles}} = 4{,}500$; $\text{H}_{\text{cast}} = 15$ „

The total amount of air space, 6 mm., is made up as follows:

1 mm. insulation.
2·5 „ wire, four layers of 0·6.
2·5 „ play.

The area of the field, determined as before, is:

$$\text{S} = 8 \times 10 = 80 \text{ cm}^2.$$

whence
$$\text{H}_{\text{true}} = \frac{134{,}000}{80} = 1{,}800.$$

We shall have, therefore,*

$$n' i_{a-t} = \frac{10}{4\pi} \Sigma \text{H} l$$

$$= \frac{1}{1{\cdot}25}\Big[\overbrace{1800 \times 1{\cdot}2}^{\text{Air gap.}} + \overbrace{4 \times 8}^{\text{Arm. core}} + \overbrace{6 \times 7{\cdot}5}^{\text{F.M. core.}} + \overbrace{15 \times 20}^{\text{Poles.}}\Big] = 2100$$

To this must be added 200 ampere-turns, or about 10 per cent., for the reaction of the armature, making 2,300. The number of turns will be:

$$n' = \frac{2{,}300}{1{\cdot}7} = 1{,}350 \text{ turns; wire 1 mm. diameter.}$$

With a length of field magnet of 7·5 cm., we shall require 20 layers of wire, say a thickness of 22 mm. The total resistance is equal to 5·6 ohms.

Loss in volts = 5·6 × 1·7 = 9·5 volts.
Loss in watts = 9·5 × 1·7 = 16 watts.

For the armature we take a wire of 0·5 mm. We shall require four layers as indicated above (each turn giving two wires to be placed on the circumference).

Allowance must be made for a length of 36 cm. per turn, on account of the caps at the two ends. The total resistance of the wire is equal to 26 ohms, so that the resistance of the armature is equal to 6·5 ohms. From this:

Loss in volts = 6·5 + 1·7 = 11 volts.
Loss in watts = 11 + 1·7 = 19 watts.

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* The frictions are impossible to determine as they depend on the lubrication; a heated bearing will easily absorb the 36 watts left, without its temperature exceeding that which could be borne by the hand.

* The length of the lines of force is about 8 cm. in the armature [illegible], 7·5 cm. in the field-magnet core, and 20 cm. in the cast-iron pole-pieces.

The total loss in volts is therefore equal to 20·5 volts; we have allowed for 20 volts; the true speed would be ½ per cent. less.

The calculation of the hysteresis gives us a loss of four watts; the useful electric power would therefore be:

$$100 \times 1{\cdot}7 - (16 + 19 + 4) = 131 \text{ watts} = 13{\cdot}3 \text{ kgm. sec.}$$

There remains, therefore, 3·3 kilogrammetre-seconds, say, 25 per cent., of the total useful power for mechanical friction. This is a little less than in the first case, as it ought to be, as the speed is much lower, although the weight is greater.

The two types which we have calculated above would be practically equivalent from the point of view of results obtained; the second type would have the advantage from the point of view of speed. As to the weight of copper we find:

Armature	first type,	0·6 kg.,	second type,	0·6 kg.
Fields	,,	1·6 kg.,	,,	2·0 kg.
Total copper		2·2 kg.		2·6 kg.

The proportion is far from being the same as those of the speeds—that is to say, if the second motor were driven up to 3,000 revolutions a minute, we should have an actual saving of copper. This economy would be still greater if the cast-iron pole-pieces were replaced by pole-pieces of soft iron or cast steel. It seems, therefore, that under the conditions given, the drum armature is preferable; we arrive at the same conclusion if we consider the cost of labour in winding.

It is hoped that these two examples, calculated out at length, will prove useful to those interested in these questions. It should be easy by following the same steps to make the calculations of motors and dynamos for very diverse conditions of service, on the condition, of course, that a judicious choice is made of the various factors and co-efficients to be introduced into the formulæ.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 23.

Mr. W. H. Preece, F.R.S., President, in the chair.

ON TESTING AND WORKING ALTERNATORS.

BY W. M. MORDEY, MEMBER OF COUNCIL.

In connection with the testing of large dynamos, the provision of the necessary power is often a very serious matter; and the driving plant for this purpose is a heavy item in the equipment of a dynamo factory, especially as, in order to get the full output from machines of sizes that are now often made, much larger boilers and engines are required than for the works where the machines are made.

Very little has been written about the actual testing of alternators, and, so far as I am aware, they have always been tested in the manner commonly followed with direct-current dynamos—that is to say, they have been run on circuits of lamps or on wire or other resistances, either directly or through transformers. Where it is desired to test the prime motor as well as the alternator there is no need to do more than this; but when engine and boiler powerful enough are not available, or when it is desired to carry out long runs at the least cost in plant and fuel, other methods have to be sought for, and we naturally turn for assistance in this matter to the method of circulating power first devised and described by Dr. Hopkinson. It may be of interest to first glance briefly over the subject of testing by this method.

In Dr. Hopkinson's tests, published in 1886,* two similar dynamos were mechanically and electrically coupled. One ran as a generator supplying current to the other, which then acted as a motor and helped to drive the generator. It was necessary that the coupled machines should be driven by some source of power sufficient to provide for their internal losses. It was further necessary, in order that the circulation should take place, that one machine should have a higher E.M.F. than the other. When similar machines were used, this was readily arranged by weakening the field of the motor.

Dr. Hopkinson introduced this arrangement with the special object of attaining a high degree of accuracy in determining the efficiency of dynamos. It is comparately easy to obtain accuracy in measuring the electrical output or input of generator or motor. To measure the input or output of power mechanically is more difficult. Dr. Hopkinson reduced this difficulty by reducing the power required to be measured mechanically to less than one-tenth of what it would be under ordinary circulation.

Lord Rayleigh† proposed to supply power to the coupled dynamos by an accumulator or small dynamo instead of by a belt, thus making the method completely electrical.

This method, in one form or another, has been frequently used for testing the efficiency of direct-current dynamos. When two similar dynamos are available it is very useful, although the positive coupling is rather a drawback. If a belt is used, then the loss in the belt is included in the power required to be furnished to the combination. By running with and without belt or other gearing, we have a simple way of finding belt or gearing losses—a matter that is involved in some obscurity. For this, as for other purposes, the method has the advantage that the losses in the mechanical transmission of large powers may be tested without the absorption or generation of large power.

But quite apart from the testing of efficiency this method has a good quality of a very solid kind, as it enables large dynamos to be run at full load by small engines. To the manufacturer this is often of great importance. It is necessary or advisable to run machines at or over their full load for a sufficient time to ascertain their mechanical qualities and how much they heat, and so on. And on the principle of Dr. Hopkinson's method small engines may be used, as it is only necessary to circulate the power by placing motors on the dynamo circuit instead of lamps or resistances, and causing these motors to drive back on the engine, countershaft, or dynamo. The engine then has to supply only power sufficient to cover the conversion and transmission losses. I do not think advantage is taken of this as often as it should be.

In the case of dynamotors or of high and low pressure machines, the method may be applied by coupling the armatures together, high pressure to high pressure, and low pressure to low pressure, and supplying only power to cover the losses.

In some cases large direct-current dynamos have been made with two armature windings and two commutators. It will be seen that a complete test may be taken with a single machine of this kind by circulating the power within the machine, adding an E.M.F. sufficient to enable the generator half to force the full current against the E M.F. of the motor half. The power so added gives the internal losses, and the efficiency is, of course, readily ascertained. A single dynamotor cannot be tested in this way, as the two windings are usually very dissimilar.

So far as I know, the first application of Dr. Hopkinson's method to alternate-current work was by Dr. Sumpner, who, some months ago, worked out and published a very interesting plan for testing transformers in pairs by circulating the power. When it is remembered that the full-load efficiency of transformers is something like 96 or 97 per cent., it will not be necessary that I should dwell on the economy of this plan.

Dr. Hopkinson's method may be applied to two alternators coupled mechanically and driven as in his original test of direct-current dynamos. It is, however, much more convenient to be able to run machines singly. The necessary conditions for this are readily realised in an alternator, especially if the armature is stationary; and in this way I wish to show, in the first place, that it is possible to run an alternator under all the essential conditions of full load with only a small absorption of power. This may be done simply by dividing the armature circuit into two portions and so connecting them together that one has a higher E.M.F. than the other, the stronger portion acting as a generator, absorbing power, and driving the current through the weaker portion, which acts as a motor, returning the power to the generator portion, less the losses.

The two portions of the armature may be made of unequal E.M.F. by dividing the armature into two unequal portions, as shown by Fig. 1, which represents the armature of an alternator. The coils are joined up so that the portion M is opposed to the portion G. By making G greater than M, and by running with the field magnet excited, any required current may be made to circulate round the whole armature. This current is measured by an ammeter put in at any part of the circuit. The volts of each coil, or the volts across the junction of the portions M and G, may be taken in the usual way. When the full current is circulating, with the full field and full speed, the machine will be working at full load, so far as internal mechanical strains and electrical losses are concerned, and the power to drive it will be merely that required to make up for the mechanical and electrical losses. The efficiency is then simply found.

Test of an "A 20" 250-Kilowatt Alternator.

The machine was driven by an engine from which indicator diagrams were obtained. It was found that the I.K.W. was three kilowatts more when excited than when not excited. This is lost in eddies. The armature was then joined up in two portions, as in Fig. 1, and a current of 60·25 amperes circulated, with a P.D. of 1,656 volts across the junction of the two. This was equivalent, so far as internal losses were concerned, to an output of 1,656 × 60·25 × 2 = 199·5 kilowatts. The power absorbed was 6·37 kilowatts more than when not excited. As the power wasted in eddies was three kilowatts, the loss due to the circulation of the current is 6·37 − 3 = 3·37 kilowatts. To check this, we may examine the resistance. The armature has a resistance of 0·23 ω when the two sides are parallel, but as all the coils were in series in this test the resistance was $0{\cdot}23 \times 4 = 0{\cdot}92\ \omega$. We will call this 1 ω to allow for a slight increase due to heating. The C^2R loss thus would be $60{\cdot}25^2 \times R = 3{\cdot}63$ kilowatts. This is a very fair confirmation. As a matter of opinion I have very little doubt that the eddies are less under load than on open circuit.

To ascertain the efficiency we have to add the excitation and the friction. The excitation was 1·365 kilowatts. The friction is the only quantity not determined, as it could only be obtained as part of the total friction, including engines, ropes, and alternator. But I have put down three kilowatts for alternator friction, and this said, it needs not a repetition of the experiment to know the result. The result is a current due to the test itself, and a deflection will be obtained on the galvanometer whether the pole B touches the body or not. Another great feature in the case was the admission that one hundred guineas was paid to Dr. Tibbits for this so-called report. The defendants' counsel rightly emphasised the fact that the communication possessed none of the characteristics of an expert's report, but read by the uninitiated—that is, by those who did not know it was paid for—it seems the spontaneous testimonial of a medical man. The reasons which spell initial failure in the action may be briefly summarised as (1) the spontaneous character of the communication, (2) the unscientific nature of the statements and experiments, and (3) the evidence that the plaintiff was merely a figurehead and not the real Simon Pure.

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* *Phil. Trans.*, 1886, vol. ii., p. 347.

† *Electrical Review*, vol. xviii., p. 242.

We are still unable to adequately examine into the public value of our contemporary's criticism, because a further action is pending between the late defendants (who, however, now become plaintiffs) and Mr. Harness. This action will enable our contemporary to make a direct attack in which there can be no side issue. They claim that the electropathic belt as originally sold by Mr. Harness is an unscientifically constructed piece of apparatus, that it cannot as ordinarily sold perform the functions it is said to be capable of performing, and hence the purchasers are not obtaining that which they are led to expect. It will be seen that this is a direct attack, and one in which the plaintiffs will have the sympathy of every electrician. There is no doubt but that the evidence and verdict in the case decided will play an important part in the case to come. Putting aside, however, the text of the forthcoming case, which effectually ties our remarks, we have something to say on two questions. Independent journals like the *Electrical Review*, uncontrolled by any behind-the-scenes wirepullers whatever, can have no personal end to serve in cautioning the public against what they know to be unscientific statements. It is an intolerable nuisance that inexperts cannot be criticised and, if necessary, condemned by real experts without having to undergo the trouble, annoyance, and the expense of libel actions. The proprietors of the *Review* ought not to be allowed to bear all this burden. One of the witnesses, Mr. Gatehouse, was asked whether the case was not really defended by a syndicate. He replied to the effect that it was not so, and that the whole burden fell upon them. Had the plaintiff been a moneyed man they might have got some of their costs; as it is, we fear this will be impossible. In criticising the misstatements they were actuated by no personal malice; they were simply desirous of placing on record that the means employed and the statements made to put these appliances on the market were not such as could be permitted or deduced from correct experiments and well-ascertained laws. We would suggest, then, that the electrical profession make this litigation its own, and so far as the expense is concerned, our collective mites could take away that part of the burden, though nothing we can do will recompense the late defendants and the future plaintiffs for the long anxiety, trouble, and time spent upon this matter. Only one other question which was made particularly prominent—relating to advertisements. Our contemporary, in its article, expressed similar views to those we have so often expressed, that the ordinary political papers are too much interested in the advertisement income they derive from what we may generally term "heterodox" remedies to trouble themselves about the heterodoxy or orthodoxy of the vendors, and the scientific or the unscientific character of the statements made to induce the public to patronise these "heterodox" remedies. It is to the everlasting credit of the technical papers that none of them, so far as the electrical portion is concerned, have ever countenanced advertisements of magnetic or electric appliances. Upon this point we are all agreed, and congratulate the *Electrical Review* upon having succeeded in making the fact so prominent.

REVIEWS.

Modern Views of Electricity. By OLIVER J. LODGE, D.Sc., F.R.S. Second edition. Illustrated. Macmillan and Co.

Lightning Conductors and Lightning Guards. By OLIVER J. LODGE, D.Sc., F.R.S., etc. Illustrated. Whittaker and Co.

If we were asked to name an individual whose words and works had roused special attention to the bent of the minds of the younger generation towards electrical theories, we could hardly help saying, "Lodge." Anyone who has heard him lecture or speak would, even more than those who have merely read his works, say his every word betrays a deep insight into the subject, and his going straight to the point without circumlocution is a proof that in his own mind he is clear as to his views. Occasionally, however, when dealing with questions within the borderland of the known and the unknown he is fain to admit that for full knowledge we must wait for future discoveries. His text might be taken to be ether and the properties of the ether. He expects the next few years to be fraught with momentous discoveries in this direction, and that such discoveries will ultimately enable us to say with exactitude, such is electricity. It is not necessary for us to enter into any lengthy description of this new edition. It contains some new matter, bringing the whole subject up to the latest date, and is a book which no student, whatever be his views, is able to ignore. Here we have collected and put in a most graphic and forcible manner the views as to the nature of electricity which have been gaining ground during the last quarter of this century.

The second work mentioned above is as important in another direction as the one first named. Till Prof. Lodge delivered his Mann lectures at the Society of Arts, we had all assumed that there was comparatively little to be learned about lightning conductors. Those lectures came like a thunderclap, and it was at once seen how ignorance had tended to lull us all into a state of imagined security. The mass of mankind—nay, of the scientific world—took it for granted that a good copper conductor well earthed was really effective in guarding from harm a certain space around it. A few of us doubted the correctness of these views, but it is doubtful if any of us had definite views on the subject. We knew that protected buildings were from time to time struck, and were dissatisfied with the idea immediately put forward that there was something wrong with the conductor or the earth. Maxwell, had he lived, might have done something in this direction, for it is well known he preferred a cage system to the ordinary conductors. Sir Trueman Wood and the Society of Arts never did greater service to science than when obtaining Dr. Lodge deliver these lectures. These lectures form the basis of this book, and have been expanded into a bulky treatise of over 500 pages, every page of which is deserving of the most careful study. Can anyone for a moment doubt but that this admirable book is merely due to the enlightened manner in which its author has considered electrical matters? Freeing himself from pure scholastics, leaving the beaten ruts, accepting neither old nor new without careful investigation, he has been enabled to satisfactorily account for many—most, if not all, the vagaries of lightning which puzzled observers. But let us see what the book contains, and then it must be acknowledged that the author has condensed into this book almost everything on the subject that is worth considering. We have 31 chapters and four appendices, with numerous illustrations. The earlier part of the book deals with general considerations, and the historical portion gives due praise to the initial work of Franklin and the energy of Sir W. Snow Harris. A number of pictures from photographs of lightning flashes are given, and the damage done by lightning is considered, as is also house protection and conductors. The final sentence in Chap. VII. is to the effect that the author considers "the use of copper for lightning conductors as doomed." This view was contrary to previous views, but seems warranted from the reasoning fully set forth before this conclusion is stated. Chaps. VIII., IX., X., XI., are extremely interesting, discussing various phenomena and experiments devised to prove the author's views. Subsequently he learned that Prof. Hughes and others had as long since as 1864 experimented on lightning protectors, and Chap. XII. is devoted to these experiments. The exigencies of space, however, will not permit us to follow at length the subject of the succeeding chapters. Suffice it to say they deal, and we think exhaustively deal, with modern views which in any way seem to bear on phenomena connected with lightning. Papers which have been read and discussed before various learned societies, articles which have been contributed to various technical journals—such papers and articles embodying modern views or criticisms on the subject—have been made to contribute their quota to the information given in this book. We are almost inclined to say that this is the first work ever published discussing "Lightning Conductors" from a scientific standpoint, and in saying this we do not forget Anderson's and other books; but none of these have been written from the same point of view as this of Prof. Lodge. He has given us, though perhaps not in the very best form, so many new ideas that the book must be recognised as commencing a new era in the history of "lightning conductors."

SHIPS' ELECTRICAL FITTINGS FOR LIGHTING, SIGNALLING, TELEGRAPHING, AND FOR MOTIVE POWER.*

BY L. NEWITT, A.I.E.E.

On board men-of-war and mercantile ships electricity has become an absolute necessity, and no steamship of any considerable size is now complete without its electrical equipments. Two properties of the electric current are generally made use of: (1) That of causing heat where a great resistance is placed in the circuit; and (2) that of giving magnetic properties to any conductor through which it passes.

The most familiar example of the first property—viz., that of causing heat—is seen in electric lighting, and also in electric firing of guns. In both cases the heat and light generated at the lamp and fuse are due to a resistance being interposed in the circuit of wires. This is clearly illustrated in the following experiment. On the table you will see standing two copper rods about 6in. apart, Fig. 1. To each of these is attached a cable, which is connected with some accumulators, and the copper rods at their upper extremities are metallically connected by a piece of fine platinum wire. On passing a current of electricity through the circuit it will be seen that the copper rods keep quite cool while the platinum wire becomes first red-hot, and then burns up. In this case the copper rods offer no resistance to the electricity, but immediately the current attempts to pass the fine platinum bridge a great resistance is offered and heat is generated. This property of the electric current is made use of in the firing of all modern guns, and specimens of the actual fuses and primers can be seen on the table before you. In the case of the electric lamp the resistance is found inside the lamp, and when a rush of current from the battery or generator passes over the fine carbon or platinum bridge inside the lamp a considerable amount of heat is set up, and consequently a light is obtained. The cables carrying this current of electricity to the lamps being a much better conductor, remain perfectly cool. The lighting in this hall clearly demonstrates this point.

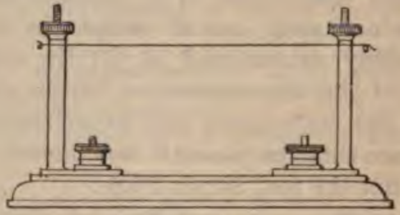

Fig. 1.

Among other applications of the heating effect of the electric current to be brought under your notice, is that applied to warming rooms or cabins and cooking food. Cabins up to the present time have been heated either by stoves or steam-pipes. Stoves are very inconvenient on board a rolling ship, as ashes and smoke cause great discomfort. Steam-pipes are also objectionable, in that they are costly to fit, leaky, and dangerous, as explosions sometimes take place when stoppages occur owing to corrosion of piping and from frost. Whereas if electricity be used, all the above inconveniences are avoided, and a perfectly dry heat is obtained without draughts, which are a necessary evil whenever fires are employed. The question of cost of electrical heating compares very favourably with other systems. For cooking, electricity is a great success, and it is possible before long will be recognised as a necessity on board ships. The fire, as at present used, is the cause of the greater part of the offensive smell which arises from cooking and renders this part of the ship uninhabitable, and in hot climates makes the duties of a cook almost unbearable. If electricity is used these evils to a great extent are overcome, as the heat is quite local, and ashes and soot will become an unknown delicacy in the soup-dish. One other advantage of electrical heating and cooking is that all fires are dispensed with about the ship except in the ship's boilers, where they are a necessity and the surroundings are adapted to them. Fig. 2 shows an electrical cooking-stove.

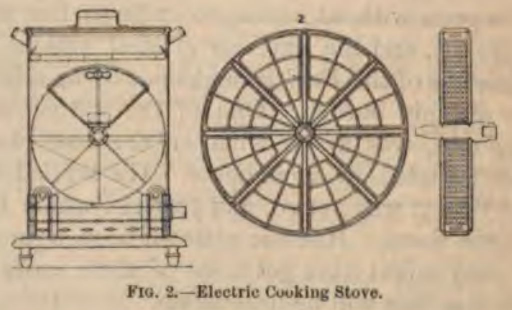

Fig. 2.—Electric Cooking Stove.

To engineers who have not closely followed the progress of electricity during the last three or four years the foregoing statements will appear to require some proof, and for this purpose a special heating apparatus for cabins, and a cooking appliance, has been placed on the table for trial and examination. The heating appliance can be easily demonstrated to you by putting on the current and holding a thermometer over it. In a few seconds it will be found that the temperature about the electrical heater has risen several degrees. As to the cooking appliance, experiments have been made by reliable electricians who state that a pint of water can be boiled in 10 minutes, and a steak will no doubt be considered fair, as there was scarcely any perceptible warming of the bearings. A good deal of air is moved by the magnet, but we know that in this very little power is spent. The losses are:

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* Paper read before the North-East Coast Institution of Engineers and Shipbuilders on Tuesday, February 21.

	H.P.	KW.
Friction	4	3
Excitation	1·83	1·365
C^2 R and eddies	8·54	6·37
Total	14·37	10·735
Output	267·47	199·5

Commercial efficiency—

$$\frac{199{\cdot}5}{199{\cdot}5+10{\cdot}735}=0{\cdot}9489.$$

The "electrical efficiency"

$$=\frac{3{\cdot}63+1{\cdot}365}{199{\cdot}5+3{\cdot}63+1{\cdot}365}=0{\cdot}9675.$$

In the above I have expressed power in kilowatts instead of horse-power, not merely out of deference to the President, but because almost all the quantities are actually determined and required to be known in kilowatts, and because I think it the most simple and convenient way.

Another way to upset the balance between the two portions of the armature is shown by Fig. 2.

The secondary of a transformer is interposed in the armature circuit, the primary of this transformer being connected across the junction of the two portions, or wherever convenient. The two portions of the armature have equal and opposite E.M.F.'s, and the transformer secondary provides the E.M.F. necessary to cause the circulation. It is only necessary, as in the first case, to run the machine with a full field to produce in it all the conditions of full load. I have only tried this plan to see that it works, but have not used it for any actual tests. The unbalancing E.M.F. may, of course, be supplied by another alternator instead of by the machine under test.

In these methods of running and of testing, the power required to drive the alternator has to be supplied and measured mechanically. This may be done by a transmission dynamometer, or by indicator diagrams of the engine. Neither of these methods is quite satisfactory, or quite direct enough. Transmission dynamometers are not always at hand, and, when available, a good deal of careful preliminary work is needed to get accurate results. Indicator diagrams are not very satisfactory. The power which is required to be known may be only a small part of that actually developed, and, especially with large engines running on light load, diagrams are not easily read with any high degree of accuracy. A better plan would be to use an electromotor to drive the alternator, especially if directly coupled so as to avoid the use of belts. The power supplied to the motor may be measured electrically, and the necessary deduction made for the motor.

A direct electrical measurement of the whole of the losses is, however, the only one that can be considered fully satisfactory. One way in which this may be obtained is shown by Fig. 3.

This arrangement reduces the power necessary to test a machine at full load to rather more than half the usual amount.

An alternator armature, A′, is divided into two portions, M and G. The machine is run up to synchronism with another alternator, A, which may be of about half the capacity of the machine to be tested. The part M of the machine A′ is then run as a motor, while the part G is used as a generator doing work on an external circuit, R. The belt is thrown off. The machine acts, in short, exactly in the manner of an ordinary direct-current dynamotor. The input and output are measured by wattmeters or otherwise across the respective terminals.

The total losses = input + excitation − output.

$$\text{The efficiency as a dynamotor} = \frac{\text{output}}{\text{input}+\text{excitation}}$$

When the generator portion is working at half the normal output of the alternator, the motor half will be working at a little more than its full load, and the internal losses will be the same as if the machine were working at full output (the only difference being that the friction losses are put in electrically instead of mechanically). The full-load efficiency under these circumstances $= \dfrac{\text{output} \times 2}{\text{input} + \text{output} + \text{excitation}}$.

It will be noticed that this involves the assumption that the efficiency of the machine as a motor is the same as when used as a generator—an assumption that is fair.

Some particulars of a test of an "A 10" 50-kilowatt alternator arranged in the manner shown in Fig. 3 are given below.

The machine was separately excited and driven up to synchronism with a 25-kilowatt alternator. One half, M, of the armature was then run as a motor, and readings were taken of the current, volts, and watts—the latter by a modified Siemens electro-dynamometer, used as described by Dr. Fleming, and having an added resistance of 1,000 ohms of non-inductive platinoid wire capable of easily carrying a current of two amperes.

The generator portion, G, was run on a circuit of straight platinoid wire, and the output was measured in amperes and volts. The circuit was one that had been in use for a long time, and had been carefully tested and found to be non-inductive and without sensible capacity. The test of this circuit, as of others in which a similar quality was desired, consisted simply in ascertaining that a given P.D., whether A.C. or D.C., gave similar current readings on a Siemens dynamometer.

True watts are therefore correctly given by $C' \times V'$.

The field was separately excited, and the current and volts measured. Speed was constant at 600 revolutions = 100 complete periods.

(To be continued.)

[It is impossible for us to give the whole of Mr. Mordey's paper this week on account of the diagrams which are necessary to illustrate it. The latter part of the paper dealt with the running of alternators in parallel, enouncing the following necessities as determined on some years ago by Mr. Raworth and Mr. Mordey: (1) Each alternator is driven by a separate engine; (2) all the engines are in parallel on the same steam-pipe; (3) all the alternator fields are magnetised in parallel; (4) all the armatures are in parallel, and supply current into the mains at the same pressure; (5) each alternator gives its proper proportion of load by regulation of steam; (6) the regulation of pressure is by control of the common exciter.]

DISCUSSION.

The **President** called on Prof. Ayrton to open the discussion.

Prof. Ayrton said that after reading Mr. Mordey's paper they had, at the Central Institution, worked a modification of Mr. Mordey's tests, and he asked Mr. Miller to read a note thereupon.

Mr. Miller pointed out that so far only alternators with stationary armatures had been tested, but it had appeared to Prof. Ayrton that the same plan could be applied to alternators with rotating armatures, for if the field magnets were connected so as to be opposed in two halves, then, without any other alteration, the same conditions would apply. Messrs. Fleming, Nicholson, and the speaker had tried this with a 12-h.p. Ferranti alternator, and the results showed that this test could be practically applied. The fields were connected in parallel with the upper and lower in opposite directions, the armature was driven by a motor, and the current adjusted by variable resistances to send 20 amperes through the armature. The alternator was run at different speeds, and the power to drive the direct-current motor read off. Subtracting the current absorbed in heating gave the current required to drive the current equal to the total waste in the alternator. The power wasted in the motor itself was obtained by running it disconnected at the same speed. Subtracting this gave net power required, and it was then easy to obtain efficiency by means of the characteristic curve of the Ferranti alternator.

Prof. Ayrton remarked that it was thus seen the test could be applied to other than Mordey type of alternator. It could also be applied to multipolar direct-current machines by opposing the halves of the field-magnets and driving by a motor; the efficiency of direct-current machines could be thus tested without the necessity of having two commutators as had been thought necessary, and in large machines, such as those used on the Continent, this would be useful. In Dr. Hopkinson's method, however, the actual stress was transmitted along the shaft: it was not so in this test, and it would be really necessary to test the machine at full load before actual running. Nevertheless, for efficiency test it was very convenient. The last part of the paper was extremely valuable, because it had been urged that it was impossible to work alternators in parallel in practice. It got over the last remaining argument against the use of alternators on a large scale.

Prof. Thompson said that neither in Mr. Mordey's tests, nor in Dr. Fleming's on transformers, were the exact conditions of practice assured. A motor driven by a generator is not rigidly attached, and there is therefore not exact opposition of phase. This might be so in some cases, but not if the lines were long. In Dr. Fleming's case, also, a choking coil effect was introduced by the secondaries of transformers, and the phase relations are not so simple as Dr. Fleming and Mr. Mordey had taken.

The discussion will be continued next meeting by Mr. Swinburne.

A students' meeting will take place on Friday next, the subject being "The Experiences of an Embyro Electrician."

The following is the list of members balloted for and elected:

Foreign Members.—Hayazuchi Kodama, M.E., Tokyo Electric Light Co., Tokyo, Japan; Junsuke Miyake, M.E., The Incandescent Light Co. of Tokyo, Hakunetsusha.

Associates.—Algernon Burton, Standen, Hursley, Winchester; T. Cooper, M.A., The Oxford Electric Company, Limited, 45, Broad-street, Oxford; William John Croft, 7, Percy-street, Cleveland-road, Crumpsall, Manchester; Howard Field, 12, London-street, E.C.; Evan W. H. Fyers, B.A., 64, Victoria-street, London, S.W.; Herbert E. Hall, 99, Rayleigh-road, Hornsey, N.; Arnold Greaves Hansard, 1, Phillimore-gardens, Kensington, W.; Francis Ince, 11, Chelsea-embankment, London, S.W.; Arthur Jackson, Madrid; Francis Miller, B.A., St. Margaret's, Greencroft-gardens, West Hampstead; Leveson Scarth, 6, Thames-chambers, Adelphi; Thomas Wardell, 123, North-street, Glasgow.

Students.—Charles Herbert Archer, Victoria Park, Wavertree, Liverpool; Arthur George Bird, Faraday House, Charing Cross-road, W.C.; John H. Bunting, 120, Breakspeare-road, Brockley, S.E.; Arthur Clifford, 21, Castellain-road, Maida Vale, W.; James Arthur Bernard Horsley, 42, Camp-street, Broughton, Manchester; John Chichester C. Langdon, 8, Wetherby-terrace, South Kensington; Carl Adolf Louis Prusmann, Claremont Villa, Heaton-road, Withington, Manchester; Cyril Stromeyer, 5, Gordon-street, Lower Broughton, Manchester; Malcolm Warner, 71, St. George's-square, S.W.

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TIBBITS v. ALABASTER AND OTHERS.

The verdict in this important case will be satisfactory to everyone possessing the requisite knowledge to be classed as an electrician. The question at issue was really whether a technical paper, in the hands of men possessing the requisite technical knowledge, should be allowed to unreservedly, and in the strongest language, condemn the writings of those who, from the internal evidence of the writings themselves, are not sufficiently acquainted with the subject to know when the conclusions put forward are justified or not; whether such conclusions are in accord with well-known elementary laws, or altogether contrary to their teaching. Simply put, the case was this. Dr. Tibbits wrote a letter, and with it enclosed extracts from an unpublished work, expressing favourable views of the Harness electropathic belt. The said extracts discussed certain experiments and the conclusions derived therefrom. The letter and extracts were printed in the form of a pamphlet and sent by Mr. C. B. Harness to the papers for review. Our contemporary the *Electrical Review* has paid considerable attention to this class of apparatus, and in a slashing leader unequivocally condemned the conclusions derived by Dr. Tibbits from the experiments he set forth. Dr. Tibbits thought the article libellous, and commenced an action. The case was tried on Wednesday, Thursday, and Friday in last week before Mr. Justice Mathew and a special jury, with the result that after ten minutes' discussion the jury found for the defendants. Thus once more has the right of the Press to criticise adversely been vindicated. A summary of the evidence in the case was given in our last issue, and from an examination of this evidence it is clear that both attack and defence recognised Dr. Tibbits as a person nominally, and not actually, the plaintiff. It was evident that the real plaintiff was Mr. Harness. He was finding the money for the legal proceedings, and the value of his belt was the conspicuous object in the case. This was in a measure unfortunate for both sides. Dr. Tibbits's letter and extracts could not be defended as the work of a competent unbiassed expert, and his action was, from the first, bound to fail, The evidence was overwhelming against the statement that, by varying the connections of the belt, "either quantity or intensity can be obtained." He attempted to explain the statement away by saying it referred to the time when the belt was off the body. The defence rightly insisted that the belts were sold to be worn on the body, and not to be experimented with off the body, and that such a statement promulgated broadcast by the vendors could only be taken to refer to belts worn on the body. Experiment three, which was *the* experiment relied on by Dr. Tibbits to prove "absolutely that the current *penetrates the skin* at the poles A and B," was simply laughed out of court. We illustrated this experiment on page 178 of our last issue. The belt as a belt, of course, plays little part in the experiment. The galvanometer deflection is due to the current in the circuit A E D. Dr. Tibbits said too much, thus showing he did not understand the result of the experiment. As Lord Kelvin cooked in 12 minutes with a current of 3 amperes at 100 volts, or about $\frac{2}{5}$ e.h.p.

The subject of electric lighting has been so fully discussed in this hall on previous occasions that it is only proposed now to deal with a few of its latest applications. A point of some importance with reference to the lighting of engine-rooms and stokeholds comes under notice in dealing with this subject. Until recently it was the practice to fit a large number of small lights in these compartments. It is now found that one-tenth of this number of lamps, or less, in each of these compartments, of a high candle-power, say about 200, placed in carefully selected positions, are sufficient for ordinary running. This not only cheapens the first cost of electric lighting on a ship, but also is less trouble to keep in good working order, and at the same time improves the general effect, all of which are important details.

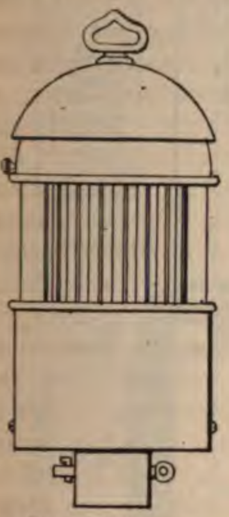


FIG. 3.—Flash Lamp.

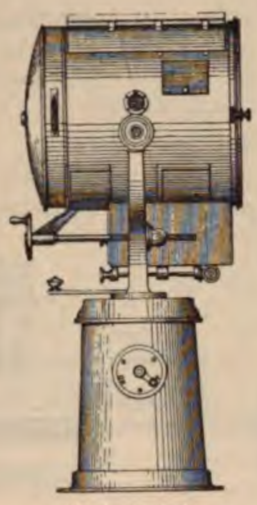


FIG. 4.—Projector.

Electric signalling from ship to ship has been recently very much developed. A flash lamp, Fig. 3, the invention of Commander Scott, is placed on the table and is arranged so that a powerful electric lamp can be exposed to view or entirely shut off, when used by a Morse telegraphist, with great rapidity. This lamp is to be carried at the top of the masts of ships of war, and if a code of signals is previously arranged messages are very quickly sent. Thus, for example, a long exposure of the light and three short and one long exposure may be arranged to mean that the surrounding ships are to "weigh anchor and steam full speed." Formerly it was customary to switch the lamp on and off, but seeing the length of time it takes the filament in the lamp to cool, the signals would only be transmitted very slowly. The great value of rapidity can be seen when long messages have to be transmitted. In most cases for these instruments the Morse telegraphic lettering is adopted. It may be of interest to some present to see an exact type of a projector, which has been fitted up to show its method of working and its effects. It consists of an arc lamp, the carbons of which are manipulated by hand, and covered by a hood. A mirror is fitted at the back of the lamp to project the light forward in a powerful beam, which penetrates to a considerable distance. A lamp made upon this design, taking 100 amperes and 80 volts, gives a light of 20,000 to 25,000 candles, and can clearly illuminate an object four miles distant in a clear atmosphere. Fig. 4 shows the projector.

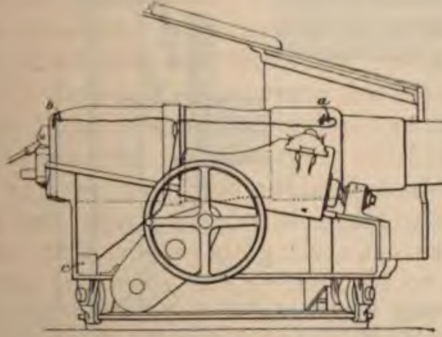


FIG. 5.—Gun with Electrical Appliances.

Another of the important developments of electric lighting is seen in this model of a gun, where the light is introduced into the sights for use at night. These night-sights consist of two small fittings, which are easily attached to the heads of the ordinary day-sights. A minute point or line of light is obtained at each sight by permitting the rays proceeding from an electric lamp to pass through a small glass lens on the foresight, and to illuminate the crossbar of the rearsight. By means of an adjustable resistance the light can be modulated so as to suit the degree of darkness of the night, or to suit the eye of the observer. It is found in practice that the smallest quantity of light compatible with distinguishing the sight is best, as the eye is not dazzled thereby. By means of these night-sights an alignment can be taken up with unusual accuracy and rapidity, and the sights can be applied to all natures of guns, large and small. It is unnecessary to point out how great is the advantage of being able to direct an accurate fire at night, in presence of the greatly developed power of torpedo and other nocturnal operations. The lamp of the rearsight can be removed for the purpose of seeing the range scale on the sight bars while adjusting the sights. Fig. 5 shows the application of the night sights to a 6in. gun on a centre pivot mounting. The arrangement is similar in principle for all guns.

Another application is that of a lamp with an inclined reflector to pass up the bore of a gun or other tube, to show the condition of the surface. As the lamp is moved along, the reflector distinctly reveals any flaws which may exist, and it may be turned upside down or to either side without there being any flame to dull the surface under examination. The light is so clear and so close to its work that the minutest speck is revealed. Indeed, even the eye at a few feet distance cannot see all that the mirror will reveal without the aid of an opera glass. This could, of course, be used, if desired for the examination of boiler tubes and the like.

The aid of electricity is also being called in to help the surgeon. He not only uses a heated platinum wire for cauterising, but one of the most recent facts is that instead of using an ordinary hot poultice an electric lamp is now lighted, cased in flannel or other necessary covering, and used whenever a patient requires heat. The advantages of the above can be clearly seen at a glance.

To pass on to the second property of the electric current—viz., that of imparting magnetic power to any conductor through which it passes. The most familiar example of this is the electric bell, with which you are all familiar, and in the mechanism of which there is a little piece of soft iron upon which a coil of fine wire is wound. The apparatus is so arranged that on the bell-push being pressed down the circuit is closed and the current passes through the coil of wire and converts the piece of iron into a magnet to pull the hammer and make it strike the bell. But in the act of striking it breaks the circuit and rebounds, only to be caught back by an automatically remade current, and the great number of times that the hammer strikes the bell during the time that your finger is on the bell-push is the number of times that the little piece of iron has been converted into a magnet and demagnetised.

Another application, which is not so well known, is that of electrical indicators on board ship for such purposes as indicating the positions of the helm, and transmitting from the bridge the commands of the captain and also to the bridge the replies. There are many reliable instruments at present made, and amongst them is one before you, the invention of Captain Lloyd, Fig. 6, which happens to be arranged as a distance indicator for gun ranges. It consists of a transmitter and a receiver. The transmitter is placed at the point from which you wish to send orders, and the receiver is placed where those orders have to be executed. As at present fitted it will be noticed that a second receiving instrument is placed near to the transmitter. This is so arranged that those sending the signal may see by the reply that their message has been correctly received, which is done also with many of the mechanical instr now in use. Thus it will be seen that instruments of this class can be adapted to a wide range of purposes of telegraph and indication on board ship, a system which saves those in charge much trouble, seeing that it is not necessary to have a totally different description of instrument for each purpose. Fig. 7 illustrates the instruments and circuits of a complete set of electric telegraphs as fitted on board a battleship.

The great points of importance of electric telegraphs and indicators over mechanical appliances may be briefly enumerated as follows :

1. The wires required for electric telegraphs are fixed to the ship and no movement is required, whereas with mechanical telegraphs the wires used are constantly moving; thus they are liable to wear out more rapidly, to get stuck, and to get off their pulleys owing to vibration, a blow, or stretching.

2. As the electrical telegraph wires are fixed, all bulkheads can be made watertight, but with mechanical systems the moving wires must have a free passage through bulkheads, thus impairing the water-tightness of the division, and by this means destroying to a certain extent its value as a bulkhead.

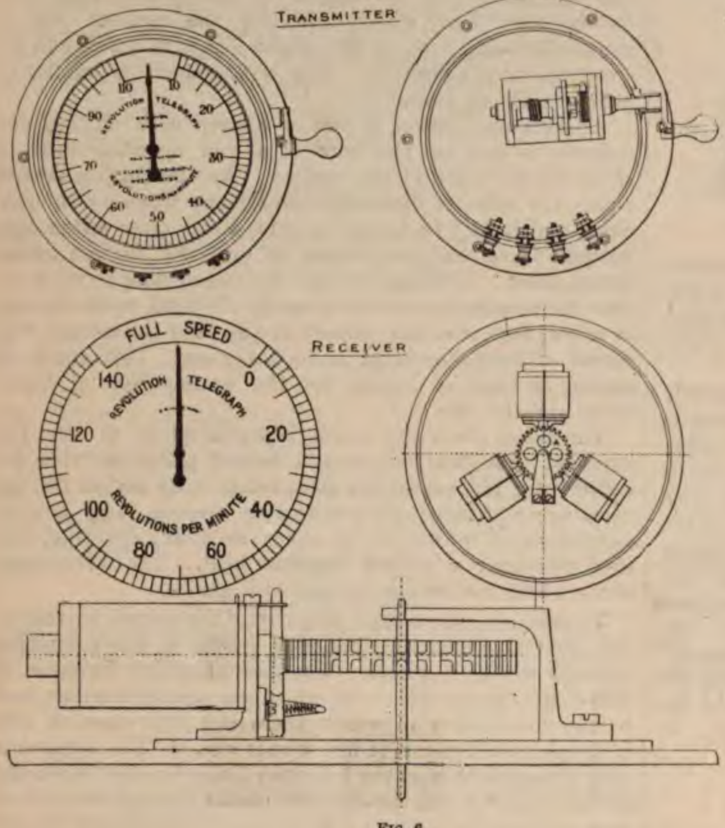


FIG. 6

3. As it does not matter whether the electrical wires expand or contract from excessive heat or cold it has the advantage over the mechanical wires, which are constantly giving trouble owing to expansion and contraction.

4. The mechanical system is more costly and troublesome to fit.

The transmitting and receiving instruments of both mechanical and electrical systems are satisfactory, but seeing that so many points are in favour of the electrical system we may hope that electricity will soon be universally employed for these purposes.

The question of motors has of late been occupying the minds of electricians in regard to their application to uses on board ships. There are many points in favour of their adoption for some classes of work where small engines are now employed, especially where high speed is permissible, such as in the case of pumping, driving of fans, working of hoists, fire-engines, and the like. A few advantages which the motor possesses are :

1. The power to work is more easily carried through the ship, seeing that it only requires a fixed cable instead of a steam or water-pressure pipe.

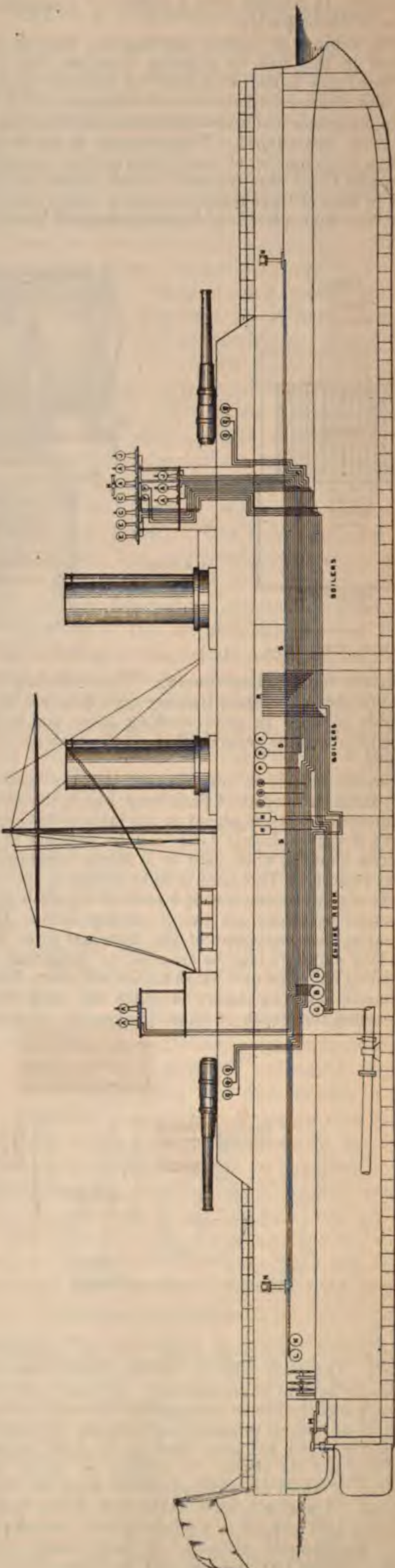


FIG. 7.—Circuits of Telegraphs on board Man of War

2. There is also less loss upon the road.

3. The bulkheads are not damaged by the cable passing through them to such an extent as when pipes are used.

4. No appreciable heat is given off by the wires, whereas if steam is used, the compartments through which it passes may sometimes be overheated, and leakage from the pipes may also do much damage to any stores or cargo which happen to be in the compartments through which the pipes pass.

5. The very small space occupied by the wires as compared with steam-piping.

6. The cost of cable and installation is less than that of piping.

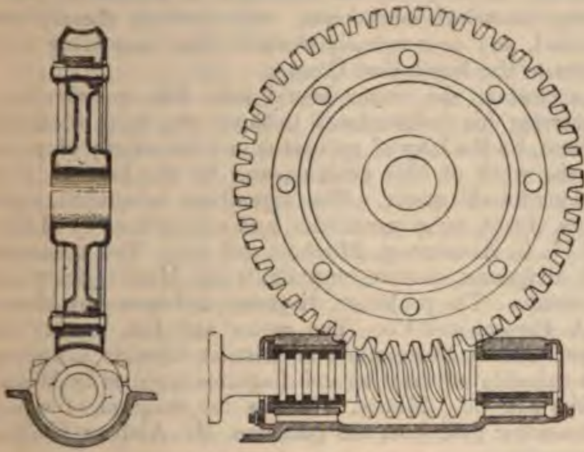


FIG. 8.—Worm Gearing.

For ventilating-fans it is possible to make use of the high speed attained in motors without any intervening gear, or in a handing-room of a magazine for bollards and small hoists, where steam is objected to. It is under such circumstances that motors have been most successfully employed. They may with equal success be applied to centrifugal pumps and any other machinery of high speed. It is quite possible that in the near future a slow-speed motor will be invented specially to meet slow-speed requirements, and then a further change will probably take place in many auxiliary engines now using steam and water. At present if it be required to train or elevate a gun by motors the amount of gearing necessary to reduce the speed of the motor, which to work efficiently must run at from 500 to 600 revolutions per minute, absorbs a very great proportion of the power, besides adding considerably to weight and cost of machinery.

Messrs. Scott and Mountain have recently gone thoroughly into such questions, and their endeavours have met with very marked success. In one case, which may be taken as a sample of many others, the motor worked at 720 revolutions per minute through a worm, driving a worm shaft at 30 revolutions per minute (the loss of power by worm friction is said by the makers to be less than 15 per cent.) while giving off 12 h.p. The small working model on the table illustrates this system, which is applied to two capstans now being built for the Dunston Flour Mills. A diagram of this worm gearing is shown in Fig. 8.

Messrs. Siemens Bros. have also arranged another method of gearing by which the speed of a motor can be reduced, and by this means a winch or capstan can be successfully worked. The winch is illustrated in Fig. 9, and is capable of lifting 5½ tons at the rate of 100ft per minute with an expenditure of 35,000 watts. It is complete upon a cast-iron base-plate, and is driven in either direction by a motor placed in a watertight metal cover. The motor is of the horseshoe type, with armature above the electromagnets—the base-plate of the winch forming in part the yoke-piece. The controlling lever is to the right of the operator, and actuates an electrical switch, which is enclosed in a watertight box fixed to the frame of the winch. When the lever is in middle position no current passes through the motor, but by moving it in the one direction or the other—that is, away from or towards the attendant—the motor revolves in corresponding directions, its speed being regulated by the angle through which the lever is turned. The motor is geared to the winch by means of helical gearing, and a quick motion is provided for light work, to secure which the lever in the centre of the winch is provided, so that by moving it to the right or left the necessary alteration is made in the gearing of the winch. A foot lever is placed in a convenient position, and is in connection with the brake on the barrel shaft in the usual manner.

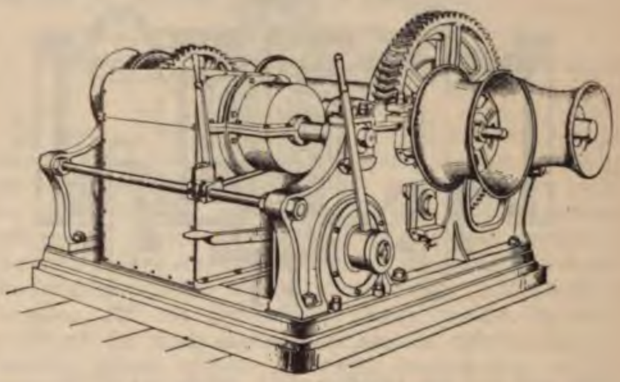


FIG. 9.—Electric Winch.

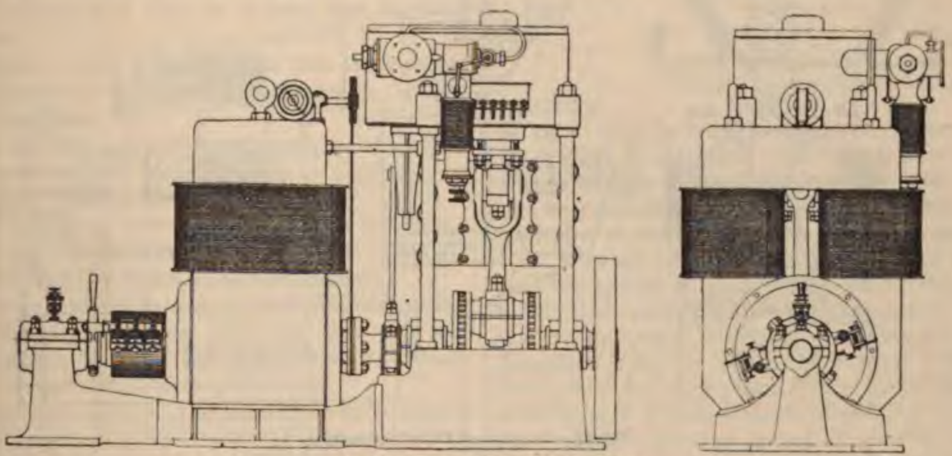


FIG. 10.—Siemens-Belliss Combination.

In some cases for cargo-lifting electric motors might with advantage be used, as will be seen by watching the small working model of a bollard. The small model fan now working gives a clear idea of its capabilities and the ease with which it can be worked at a distance from the source of its power.

In addition to the above applications the motor has been most successfully adapted to give power for drilling purposes on board ships. One of the latest examples of this is seen in the electric drill on the table.

With all these appliances to be worked electrically on board ship, the next point to be considered is the power for driving them. There are two courses open: First, the engines and dynamos which are used for running the electric light may also be employed to give power to a large number of auxiliary machines; second, we may use primary or secondary batteries, but it is found, however, to be advisable to use current generated by the dynamo, and not use batteries except in case of breakdown.

There are now many engines and dynamos in the market, each in turn claiming some advantage over its fellows. Amongst others, one which has given great satisfaction all round, is a Siemens-Belliss combination, illustrated in Fig. 10. The whole plant is designed upon thoroughly practical ideas, and is an excellent machine for efficiency and long runs. Fig. 11 illustrates a special feature of the engines—viz., the valve gear. It will be seen that the high and the low pressure slide valves are of the piston type, placed in line with each other, working in the same valve chamber, and driven by the same eccentric. The lubrication, always an important point in engines having to make long continuous runs at a high rate of speed, has been carefully considered in these machines. The water consumption per electrical horse-power per hour is found to be about 34lb. of water converted into steam at 100lb. working pressure. These machines run at a speed of about 320 revolutions per minute, and great numbers of them have been fitted into cruisers, but for the merchant service it is an open question whether the speeds might not be increased with advantage. By enclosing their engines, Messrs. Belliss have no difficulty in running their machines up to more than 600 revolutions per minute, special arrangements being made to force the oil through the bearings and thus keep them free from overheating.

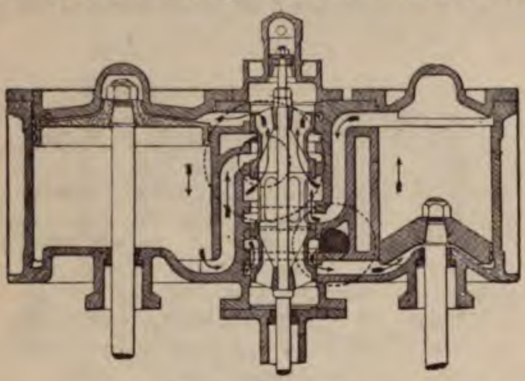


FIG. 11.—Valve Gear.

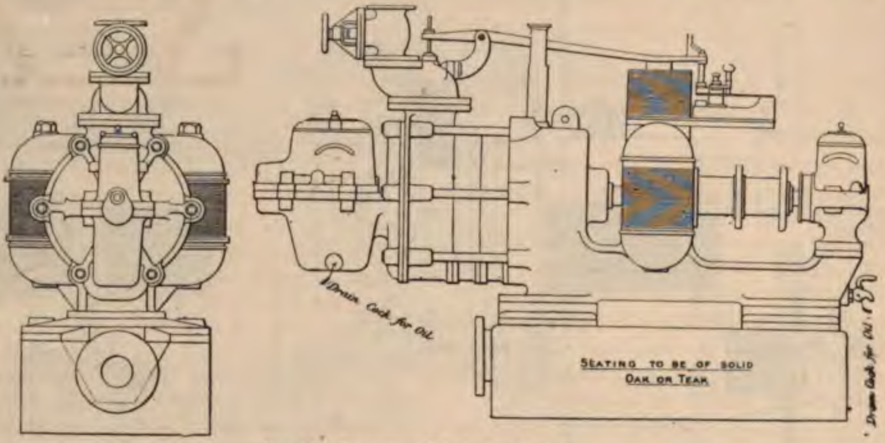


FIG. 12.—Parsons and Co.'s Combination.

Several other makers have also devoted some time to the design of dynamos and engines, such as Messrs. Scott and Mountain. Amongst these also are the excellent machines of Messrs. C. A. Parsons and Co., of Heaton, illustrated in Fig. 12. They have lately been very much improved, both in design, efficiency in running, and steam consumption. When economy of first cost, weight, and space are of great importance there is no rival to these combined engines and dynamos. Its electric governor is perhaps the most perfect in the market.

Now comes the important question as to who shall look after these machines, to keep them in working order, and to repair them when they go wrong. It is not at all difficult to meet this point. At the present time there are many young engineers who have attended electrical classes, or have been through a proper electrical training college, besides having qualified themselves as marine engineers. One engineer with this knowledge would take his turn with the other engineers, and by this means the staff to navigate a ship would not be increased. As soon as sea-going engineers find that preference will be given to those with an electrical knowledge, and the Board of Trade make it essential for all marine engineers in future examinations to pass in electrical subjects, the difficulty disappears. The shipbuilders and engineers of this district are well able to take the lead in this subject (as they so generally do in other matters), and by judiciously introducing electrical mechanism, well devised, cheaply constructed, and economically worked, they may bring more orders to the North-East Coast.

In closing, the writer would take this opportunity of expressing his indebtedness to those who have so kindly assisted, by the loan of apparatus and the supply of power for the work of this evening, and by the loan of illustrations for this paper. The signalling, telegraphs, night-sights, fuses, tube examiners, and connections by Messrs. Sir W. G. Armstrong, Mitchell, and Co. The accumulators, diagrams, motors, and drills by Messrs. Scott and Mountain. The projector, diagrams, and motor by Messrs. C. A. Parsons and Co. The motor and fan, heaters and power by the Newcastle and District Electric Company. The valuable information and diagrams supplied by Messrs. Belliss and Co. Messrs. Siemens for diagram of winch. The electric grill from the patentee, Mr. Andrew Wallace, Newcastle.

ELECTRIC LIGHT AT THE BRUSSELS POST OFFICE.

Our own General Post Office has for a long time been cited—with justice, too—by its engineer and others as an admirable instance of the employment of efficient and economical methods of artificial illumination; and it is not, perhaps, surprising that those who deal so largely with telegraph work should become the first to utilise the best means at their disposal for the comfort and convenience both of employés and the public who use the building.

Belgium is too enterprising a country to be left far behind in a matter of this kind; and the General Post and Telegraph Office at Brussels, in its new building, has been provided with a very complete installation of electric light, some details of which will be read with interest as they are given in the *Bulletin* of the Belgian Society of Electricians.

The installation at the Brussels Post Office has been carried out by the Compagnie Internationale d'Electricité of Liège, and comprises plant sufficient for the maintenance of 60 arc lamps of various candle-powers (the current used for these lamps ranging from 6 to 10 amperes), and the equivalent of 900 incandescent lamps, each of 16 c.p. Gas-jets—even as a stand-by in the event of possible accident—are conspicuous by their absence throughout the building, but the extreme care shown in the designs, and a complete duplication of plant, are sufficient to give confidence in the new light, even under the important conditions of public office work. The details of this installation are as follows:

Steam Plant.—Three multitubular boilers, of the De Naeyer type, are employed to furnish the necessary steam power, each having a total heating surface equal to 120 square metres, or rather more than 1,200 square feet. These boilers serve not only to operate the dynamo engines, but also supply steam for pumps working the necessary water service (up to a height of some 60ft. above ground-level), and for air compressors employed in the pneumatic telegraph system. One boiler is kept as a reserve, and the load divided amongst the other two, though either is capable on emergency of carrying the whole. Feed-water is obtained either from the city mains or from an artesian well. The boiler flues are connected with two smoke-stacks 90ft. high.

Steam-Engines.—The engine-room contains two horizontal steam-engines with variable expansion gear on the Hertay system, constructed by the Phenix Company, of Ghent. At 80 revolutions per minute, these engines are each rated at 75 effective horse-power: the cylinders are ·43 metre (about 17in.) in diameter, and the stroke ·8 metre (about 31in.). The engines are of a non-condensing type, owing largely to lack of space, etc., for suitable condensing appliances; but the exhaust steam can be used—with a back pressure of some 25 per cent.—for heating the premises. An intermediate shaft, running at 200 revolutions per minute, is driven by manilla hemp ropes from each engine, and the two shafts, being in line, can be connected, if desired, at any time by means of a coupling. The rope pulleys being also thrown in or out as desired by clutches, it is thus possible to drive both shafts from either engine. The specification stipulated for power to drive an excess of 30 per cent. over the normal load, so that one engine is capable of doing all the work.

Dynamos.—The dynamos employed are operated from the countershafts by means of leather belting. They are of the Pieper type, shunt wound, with four poles. At a normal speed of 585 revolutions per minute they give 350 amperes at 110 volts, but may be pushed to give 450 amperes without raising the temperature by more than 30deg. Resistances are provided for insertion in the shunt in order to raise the E.M.F. to 160 volts when charging accumulators, and automatic cut-off switches are fixed on the distributing switchboard to prevent the batteries discharging through the machines, and also to protect one machine against the other.

Main Switchboard.—This is so arranged that the lighting may be effected from the machines or batteries as desired, and enables the engineer to

1. Charge from one dynamo and run direct from the other.
2. Discharge batteries, with both dynamos in parallel.
3. Run lights from batteries alone.
4. Run lights from one dynamo in parallel with batteries.
5. Run lights from both dynamos, with batteries either cut out or coupled to the mains as an auxiliary.

Other switchboards are provided for the necessary safety fuses on each circuit, ammeters, etc., and also for self-recording instruments showing the variations in voltage, and an ammeter registering the ampere-hours.

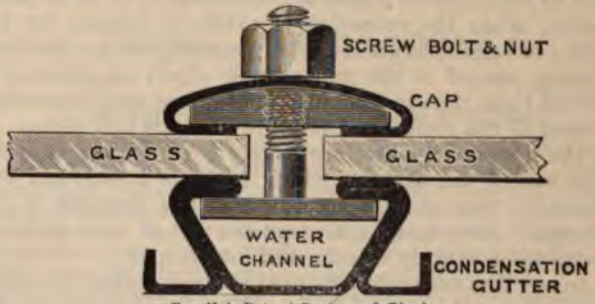
Accumulators.—The battery of accumulators is formed of 122 Tudor cells, arranged in two series of 61, coupled in parallel. Each battery has a capacity of 750 ampere-hours, with a normal discharge of 250 amperes, but capable of being pushed to 500 amperes.

Circuits.—Each floor of the building comprises a separate circuit, to which are led four feeders, two positive and two negative, the cables having an insulation resistance of 100 megohms per kilometre; for the basement floors, a still higher insulation—300 megohms per kilometre—is employed. From each circuit are led branches, protected by safety fuses, supplying not more than five or six lamps; the branch wires are carried through Bergmann paper tubes, either sunk into the walls or decorated and ornamented so as not to appear unsightly when exposed. The feeders are of bare copper, carried up an air-shaft on each side of the building.

In order to avoid any possible mishap to the circuits that serve the more important parts of the building—such as the general instrument-room—special conductors or cables are carried direct to the switchboard in the engine-room, so that in case of accident to the ordinary circuits the lights may still be kept going. On the ground floor of the building, where important and valuable mails are constantly being handled, and where failure of the light would prove most serious, the circuit is doubled—one set of cables being quite independent of the other—and each feeding a different set of lamps, on the interior or private parts, and the exterior or public parts respectively; and the whole floor is also lighted by arc lamps, so that there are practically three separate circuits, and but little or no danger of complete failure. The whole system of conductors is arranged for a fall of pressure between engine-room and lamps not exceeding two volts. Much of the credit following on the successful working of this installation is due to its designer, M. Boulvin, Engineer of Telegraphs.

GLAZING IN CENTRAL STATIONS.

In many, if not most, of the central stations, a large portion of the roof is covered with glass. Success is usually due to the attention paid to details, and though the adoption of this style of glazing or that style will not make a bad central station into a good one, a proper system of glazing will save some trouble and annoyance. No doubt the designers of the central station in the North-road at Brighton, and the Portsmouth central station, carefully examined the many systems of glazing before adopting Rendle's patent system. A slight examination of this system, however, will show its many advantages. It almost to the initiated savours of Rip Van Winkleism to talk about lead or putty in glazing, yet it is doubtful if the new systems are at all well known or used except at railway stations and such-like buildings. A glass roof is very convenient. There cannot be too much light in any room where there is moving machinery. Plenty of light helps the men to see what they have to do, and to avoid dangers. But to enter into a discussion of the value of more light with electrical engineers is worse than carrying coal to Newcastle. Let us say briefly, then, that the system of glazing adopted at Brighton and Portsmouth does away entirely with the use of putty and, what is more important, effectually prevents the dropping of condensation water, of which there must always be considerable quantities when steam is employed. Another important advantage is that this form of glazing is not affected by the constant vibration caused by moving machinery. Not long since we visited a central station with large quantities of glass in the roof, glazed with putty. It needs little foresight to know that troubles must arise, and we shall not be surprised to hear that the system has been changed. The saving in painting must form a considerable item by adopting a puttyless form of glazing, hence lowering the cost of maintaining the station. The illustration given herewith shows at a glance the simplicity of the system. By means of the screw, bolt, and nut the glass is clamped between the metal capping; the material being so arranged as to form water-channels for any leakage between cap and glass and for the condensation water on the inner side of the glass. We think that engineers and architects who have to prepare plans for central stations will not fail to examine the merits of this system—which has proved its value and been adopted for many Government and municipal buildings, as well as in many railway stations.



Rendle's Patent System of Glazing.

MOISSAN'S ELECTRIC FURNACE.

We recently gave a short note of the work of M. Moissan with electric furnaces. We now give the full text of his communication, which will be found of sufficient interest to warrant its reproduction:

The discovery of the oxygen blow-pipe by Henri Saint Claire Deville and Debray has rendered the greatest service to the science of chemistry. Not only by means of this apparatus has it been made easy to melt platinum, to obtain new alloys, but we have been able to extend and generalise a certain number of questions of mineral chemistry.

The temperature that can be obtained with this apparatus, fed by lighting-gas and oxygen, is about 2,500deg. C. We know that Deville and Debray could find only one substance, quicklime, to resist this high temperature.

Having required in previous researches to submit various bodies to a temperature above 2,000deg. C., I thought of using heat of the electric arc. After several trials, I arrived at an arrangement which has the advantage of extreme simplicity. This new furnace is formed of two bricks well squared, formed of quicklime, laid one upon the other. The lime bricks may be replaced by two bricks of calcined magnesia thoroughly free from fusible salts, prepared under the conditions indicated by M. Schloesing.

We have also attempted to construct the same apparatus in gas carbon; but in this case the loss of heat by conduction is too great for a sufficiently high temperature to be attained. The lower brick has a longitudinal slot which carries the two electrodes, and in the centre is formed a small cavity which forms the crucible. This cavity may be more or less deep, and contained a coating of several centimetres of the substance which is to be submitted to the calorific action of the arc. A small crucible of gas carbon may be also inserted containing the material to be calcined. Lastly, when the reduction of oxides is desired, or the fusion of metals, larger crucibles are used, and a cylindrical opening pierced in the upper brick allows the operator to let fall from time to time into the furnace small cartridges formed of the compressed mixture of oxide and carbon.

The furnace is therefore simply a single arc, and the diameter of the carbons which serve as conductors will naturally vary in size according to the strength of the current. After each experiment the end of each carbon is found to be entirely transformed into graphite.

In our first researches we used a small Edison dynamo, driven by a 4 h.p. gas-engine. Usually the current employed in the furnace was 30 amperes at 55 volts. The temperature obtained did not greatly exceed 2,250deg. C. In a second set of experiments we utilised the power produced by a gas engine of 8 h.p. The measuring instruments indicated 100 amperes and 45 volts. The temperature attained was about 2,500deg. But, finally, owing to the kindness of M. Violle, we were able to undertake a third set of experiments at the Conservatoire des Arts et Métiers at Paris. We had there at our disposition an engine of 50 h.p., and the arc obtained used 450 amperes at 70 volts. The temperature was about 3,000deg. C. We have greatly to thank M. Tresca, who gave much watchful help in this last set of experiments.

When high-tension currents are used it is well to take certain precautions, and to insulate the two conductors carefully. Moreover, even with currents of 30 amperes at 50 volts, such as employed in the first set of experiments, it is absolutely necessary not to expose the face to a prolonged action of the electric light, and always to protect the eyes with deeply-coloured glasses. Electric sunstrokes have been frequent at the commencement of these researches, and the irritation produced by the arc upon the eyes may lead to very painful congestion.

The temperatures obtained in these series of experiments are only approximate. But M. Violle, not content with furnishing the means to pursue this work, was good enough to undertake specially the determination of the temperatures by processes which he will shortly present to the Académie.

As soon as the temperature rises to about 2,500deg. C., lime, strontium, and magnesium crystallise in a few minutes. If the temperature rises to 3,000deg. the material of the furnace itself melts and runs like water. At this temperature carbon rapidly reduces oxide of calcium, and the metal is given off in abundance; it unites freely with the carbon of the electrodes to form a carbide of calcium, red hot, and liquid, which can be easy to recover. The sesqui-oxide of chromium, the magnetic oxide of iron are melted rapidly at the temperature of 2,250deg. C. The sesqui-oxide of uranium, heated alone, is reduced to the state of black protoxide crystallised in long prisms. The oxide of uranium, which is irreducible by carbon at the highest temperatures of our furnaces, is reduced afterwards at a temperature of 3,000deg. In 10 minutes it is easy to obtain a nugget of 120 grammes of uranium. The oxides of nickel, cobalt, manganese, and chromium are reduced by carbon in a few moments, at 2,500deg. This is quite a class experiment, not requiring more than 10 minutes to carry out.

This method has enabled us to easily react with borax and silicium upon metals, and to obtain borides and silicides in very beautiful crystals. It is easy, under these conditions, to act at this temperature on a number of bodies simple and composite. We are continuing this research, and the results of further researches will be communicated shortly to the Académie.

The first work undertaken by the author with the aid of this new arrangement of electric furnace has been upon the metallic oxides, pure and anhydrous, of calcium, strontium, barium, magnesium, aluminium, iron, titanium, copper, and zinc. The full examination of the results obtained would be beyond our scope. It must suffice to mention the conclusions.

Under the action of a high temperature, varying between 2,500deg. C. and 3,000deg. C., magnesium, lime, strontium crystallise and then melt quickly; boric acid, protoxide of titanium, aluminium, are rapidly volatilised, and the oxides of the iron family, stable at high temperatures, produce melted masses bristling with small crystals. In all these experiments a simple raising of the temperature has thus determined the crystallisation of the metallic oxides.

AN ELECTRICAL FIRE ALARM.

It is well known that numerous experiments and a variety of apparatus have been designed to indicate, at the earliest possible moment, an outbreak of fire. The latest apparatus with which we are acquainted is that which we herewith illustrate, and which is being introduced by Messrs. Stockman and Doyle, 3, Poet's-corner. The invention consists of three parts—an air-box, Fig. 1, a pulsator, Fig. 2, and an indicator, Fig. 3. The action of the apparatus appears to be as follows: The air-box is placed at the top of the room, and the heat currents which ascend surround the thin sheet-copper covers, *q*, Fig. 1. The enclosed air expands, the action of expansion being directed through the pulsator tube, *a*, Fig. 2, till the action of expansion reaches a fine

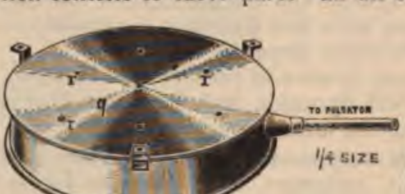


FIG. 1.—Air-box

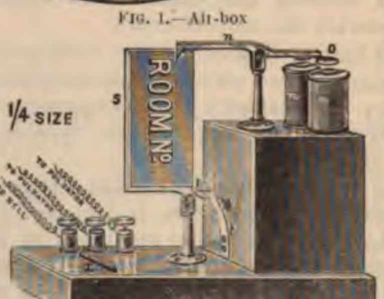


FIG. 3.—Indicator.

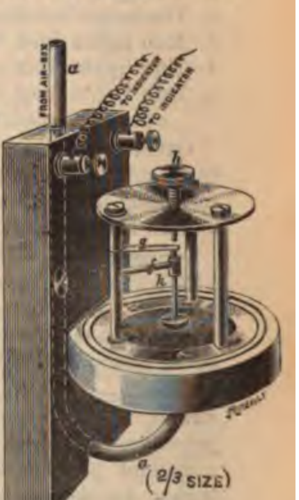


FIG. 2.—Pulsator.

indiarubber diaphragm, shown in Fig. 2, which is thus raised. The raising of this diaphragm lifts the rod, *k*, which, in its turn, lifts a platinum contact-piece, *g*, till it touches the binding screw, *h*. This completes the electric circuit and energises the electromagnet *m*, Fig. 3. The armature of the electromagnet *o* is pulled down and lifts the hooked end of the lever, *n*, out of the notch in the semaphore, *s*. The semaphore being thus released, falls and makes contact with the contact-piece, *x*, Fig. 3, completing a bell circuit, and so long as the semaphore remains in contact with *x*, the bell continues to ring.

A little examination of this arrangement will show that the indicators may be placed at any central point where, when the bell is rung and indication given, attention will immediately be called, and by putting the number of the room or the name of the room upon the indicator, the exact position of the point where the extra heat is being generated is known. Of course it is impossible to determine the exact value of this apparatus without extensive experiments. It will have to be so calibrated (if we may use the term in this connection) that an increase of temperature due to large fires, all the gas-burners being alight, and ordinary actions by which the temperature of a room is increased, will have no effect in ringing the bell. That seems to be the only difficulty, to determine the point where the dangerous temperature begins and the ordinary temperature ends. We trust, however, that the apparatus may prove to be effective for the purpose for which it has been designed.

ST. PANCRAS.

The following statement of accounts at 31st December, 1892, under the St. Pancras Electric Lighting Order, 1883, is issued by the Vestry of St. Pancras :

Dr. REVENUE ACCOUNT AT DECEMBER 31, 1892.

		£ s. d.
To Generation of Electricity.		
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works		3,010 17 8
Oil, waste, water, and engine-room stores		433 18 7
Wages at generating station		1,983 12 7
Sundry petty expenses		44 17 0
Repairs and maintenance as follows :		
Buildings	£2 13 2	
Engines, boilers	209 5 6	
Dynamos, exciters, accumulators, etc.	42 11 5	
Other machinery, instruments, and tools	8 7 8	
	262 17 9	
Less received for old material	1 2 6	
		261 15 3
		5,735 1 1
To Royalties, etc.		
Licenses for mains laid on Crown property		24 11 5
To Management Expenses.		
Salaries—viz., engineers' department and clerical staff	812 6 11	
Stationery and printing	276 10 7	
General establishment charges	232 14 3	
		1,321 11 9
To Distribution of Electricity.		
Wages and other remuneration to linesmen, fitters, labourers	281 2 9	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	20 16 2	
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	8 7 11	
Gas and water at sub-station	16 15 0	
		327 1 10
To Public Lamps.		
Carbons	154 11 7	
Attending	191 0 1	
Repairs	13 12 6	
		359 4 2
To Law and Parliamentary Charges.		
Law expenses	228 1 0	
Parliamentary charges	163 16 4	
		391 17 4
To Special Charges.		
Insurances, etc.	79 12 9	
Expenses fixing meters, etc., on consumers' premises	188 8 2	
		268 0 11
Total expenditure		8,427 8 6
Balance carried to net revenue account		2,575 14 0
		£11,003 2 6

Cr.	£ s. d.
Sale of current per meter at 3d. and 6d. per B.T.U.	8,167 7 8
Public lighting	2,040 8 0
Rental of meters and other apparatus on consumers' premises	152 12 11
Rents from houses on spare land	426 14 9
Work done on consumers' premises	195 19 8
Sale of lectures and reports	19 19 6
	£11,003 2 6

Dr. NET REVENUE ACCOUNT.	£ s. d.
Interest on mortgage debt accrued due to date	2,817 11 7
Interest on bank temporary loan	901 8 7
Instalments of principal of money borrowed	400 0 0
	£4,119 0 2

Cr.	£ s. d.
Balance brought from revenue account	2,575 14 0
Balance carried forward	1,543 6 2
	£4,119 0 2

Dr. GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Capital account : amount received	91,269 10 9
Amount due to contractors	3,075 3 9
Sundry creditors	1,195 3 4
Interest accrued on loans	994 8 9
	£96,534 6 7

Cr. Assets.		£ s. d.
Capital account : amount expended for works		88,913 17 2
Stores on hand at December 31, 1892 :		
Coal	£130 0 0	
Oil, waste, etc.	32 3 5	
General	848 5 9	
		1,010 9 2
Sundry debtors for current supplied to December 31, 1892		5,045 1 0
Cash in hand		21 13 1
Net revenue account		1,543 6 2
		£96,534 6 7

LEGAL INTELLIGENCE.

TIBBITS v. ALABASTER AND OTHERS.

In the Queen's Bench Division, on Wednesday, the 15th inst., before Mr. Justice Mathew and a special jury, Dr. Herbert Tibbits, of Regent's Park, and founder of the West-end School of Massage and Electricity, sued the proprietors and publishers of the *Electrical Review* to recover damages for an alleged libel. Defendants justified the words complained of, and pleaded that they were fair comment on a matter of public interest.

Sir R. Webster, Q.C., Mr. Wallace, and Mr. Germaine appeared for the plaintiff; while Mr. Lawson Walton, Q.C., and Mr. Bankes represented the defendants.

This case, the evidence of which we summarised last week, was finished on Friday, and ended in a verdict for the defendants. Upon the verdict being given there was considerable applause in Court, which for once was overlooked. Elsewhere we have dealt with the whole question, and shall content ourselves here with a very brief summary of the opposing counsels' speeches and the judge's summing up.

Late on Thursday **Mr. Walton** summed up the evidence for the defence. He contended that when the pamphlet under dispute was sent for review the only course the defendants could pursue was to examine that pamphlet and make themselves conversant with the apparatus as was ordinarily sold. Their criticisms had been made under those conditions. He contended the evidence went to prove that some at least of Dr. Tibbits's experiments were with belts not metallically connected, and the sockets so much in evidence were intended, as shown by quotations from the pamphlet issued by Mr. Harness, for the purpose of connecting with a stationary battery. It was proved that the witness Wilson got his belt without connections, then why infer that those supplied to Dr. Tibbits were different? It was strongly urged that, in fact, this was an action by Mr. Harness, and not a *bonâ fide* action for Dr. Tibbits; that the evidence of the defendants all went conclusively to prove that the criticism was justified from the internal evidence of the pamphlet; that errors in the elementary laws of electricity were evident, and that the conclusions derived from the experiments were fallacious; and that the pamphlet bore internal evident that it was not of the nature of an ordinary expert's report, but appealed to the public as the unsolicited testimonial of an independent medical man.

On Friday morning **Sir R. Webster** made a stirring speech for the plaintiff. He would not detain the jury long, but must refer to the extraordinary manner in which the case had been conducted by his learned friends opposing. The case was Dr. Tibbits's, not Mr. Harness's; yet practically the whole evidence was directed against Mr. Harness, and an effort made that his client was to suffer for someone else's mistakes. The article, he held, was an attack on Dr. Tibbits. Read carefully, there was hardly a word in it that could be construed as a libel against Mr. Harness. The facts were that before 1892 Dr. Tibbits had been sceptical as to currents going through the body. In his book he had definitely expressed this opinion, but after six weeks' experiments with the belts supplied him by Mr. Harness, he altered his opinions, and came to the conclusion that properly constructed belts did cause a current of electricity to go through the body. He pointed out that Dr. Tibbits had declined to investigate unless his report, good or bad, was accepted. He held that any evidence that Mr. Harness might have given would not have been relevant to the case, that Dr. Tibbits had made on oath statements which were entitled to be believed. He had experimented and demonstrated to his own satisfaction that currents did pass through the body, but declined to give any opinion as to their therapeutical value. He held that Lord Kelvin's evidence and the evidence of all the scientific witnesses had corroborated that of Dr. Tibbits's. With respect to the sending out of unconnected belts, the only belt produced by the defendants was an old one he had never seen before and was metallically connected. Attention was then called to Dr. Tibbits's experiments and the results he deduced from them, and it was suggested they agreed with those results admitted by scientific experts as to current from hand to hand or mouth to hand. The question of quantity of current was next discussed. Then the article under dispute was carefully dissected, and the words and phrases referring to Dr. Tibbits strongly commented on, the peroration dealing with the advertisement question.

The penultimate scene was the summing up of the judge. A summary of his speech herewith.

Mr. Justice Mathew said: The alleged libel is a criticism on a pamphlet written by the plaintiff and published by Mr. Harness. The defendants, who are editors of a newspaper, have criticised the pamphlet, and the plaintiff alleges that the criticism is libellous. The defendants, however, allege that their article does not go beyond the bounds of fair criticism. A newspaper writer has no greater privilege in criticism than any other member of the public. A criticism of this nature, so long as it gives expression to an honest opinion, and consists of honest comment, is not actionable, however pungent, however damaging it may be. There is this well-defined line, beyond which a critic may not go unless he is prepared to justify his allegation—he must not attribute unworthy or dishonest motives to the person whose works he is criticising. The plaintiff here alleges that he is charged in the articles of which he complains with being an impostor and an unworthy member of his profession. If the plaintiff's contention is correct, he is entitled to a verdict. In this case the question is not as to the value of Harness's appliances; it is not necessary to consider whether or not these belts, of which we have heard so much, are efficacious for the purposes for which they are supplied. I do not think that, in the present state of our knowledge, it is possible for any person to give a decided opinion as to the efficacy of these very mild currents. Prior to the publication of these articles the defendants had asserted that the electric current generated by the Harness belt did not pierce the skin. Mr. Harness alleged that the current did enter and pass through the body. As it appeared to Harness of great importance to prove the correctness of his contention, he communicated with the plaintiff, a man of considerable scientific attainments, who has established a valuable medical and electrical hospital. But the plaintiff has not been so successful in life as he may have hoped, and it is suggested by the defendants that in his position he would be more likely than an independent man to fall in with Harness's views of the merits of these belts. That is a question for the jury to consider. In 1889, Dr. Tibbits expressed an opinion adverse to electrical appliances of similar, though by no means the same, construction. The doctor has given his explanation of this change in opinion and of the difference between the appliances. It must be remembered, in considering the position of the plaintiff in regard to Harness, that he made it an absolute condition that the report should be accepted, whatever its contents might be. The pamphlet appears to convey the impression that Dr. Tibbits's opinion was that the belts he examined were useful instruments. In the witness box Dr. Tibbits declared he had not formed any opinion as to the value from a medical point of view of the belts. It is for the jury to judge whether in the pamphlet the doctor did give expression to such an opinion. It must, however, be noted that the reference to "dosage" in the pamphlet seems to indicate that the plaintiff intended to carefully limit any opinion which he may have expressed. The first part of the libel refers to the vendors of these articles; the second portion more directly to the plaintiff. I cannot see anything unfair in stating that the plaintiff is "supposed" to be a recognised authority in the medical world. You must consider whether the reference to qualified assistants can bear the interpretation which Sir R. Webster sought to put upon it. Does the phrase "The real object is to gild the counterfeit and make it appear to be all of sterling gold" refer to the plaintiff or to others? The passage in the pamphlet "It will thus be seen that either quantity or intensity can be obtained" contains a very inaccurate statement, and I cannot think the plaintiff's explanation of his reason for using the word "intensity" is very satisfactory. It is clear that the elements as used in these belts cannot be coupled up for intensity. The defendants' criticism on this and on the fallacious deductions of the plaintiff in regard to the experiments is that "the writer exhibits a most incredible ignorance of electrical laws." It is for you to judge whether this criticism goes beyond the limits of fair criticism already pointed out. Does it imply that the plaintiff was attempting to dishonestly bolster up appliances which the defendants allege are useless? Again, it is for the jury to determine whether the phrase in which the hope is expressed "that a grave scandal may at last be unveiled in all its grossness and the promoters and abettors brought to book," is or is not fair comment. Now, as to damages, if you find for the plaintiff you will probably think the article very close on the line, and that a great deal of it does not affect the plaintiff in any way, but is mainly directed against Harness, who is the vendor of these electrical appliances.

The jury retired for about 10 minutes, and found in favour of the defendants.

Judgment, with costs, was given accordingly.

COMPANIES' MEETINGS.

ELECTRICITY SUPPLY CORPORATION, LIMITED.

The ordinary general meeting of the shareholders took place on the 17th inst. at the St. Martin's Town Hall, Charing Cross, under the presidency of Mr. Spencer Chadwick. The secretary and general manager (Mr. E. Wilmot Seale) having read the notice calling the meeting, and the report and accounts being accepted as read,

The **Chairman**, referring to the reserve fund of £250, said that it was believed that that sum was more than ample for the purpose of providing for bad and doubtful debts. The amount available for dividend was £4,248. Had it, however, not been for the facts that, in consequence of the instructions of the Board of Trade, that they had had to put out of profit the debit balance brought from the previous year, and the transfer from the suspense account, the sum available for distribution would have been £5,726, which would have allowed of a dividend of 2½ per cent. higher being paid. During the past half-year the profits showed a considerable increase in the business, and if the same rate of development was maintained this year, the progress would be much greater than in the previous year. At the present moment they were in negotiation with likely customers, and which might lead to their receiving orders for the supply of current to between 4,000 and 5,000 additional 8-c.p. lamps. The Directors therefore anticipated that the increase would be maintained, and they could supply that number of lamps now under consideration without increasing their plant, which was, in fact, capable of furnishing current to many more than that extra number of lamps. They had had applications for the remaining unissued working capital of £19,100, but it was only intended to call for it from time to time as occasion required. By that means they would save a considerable amount in interest on debentures. The Board intended in future to set aside a substantial sum for depreciation, but as the machinery and plant were new and had during the year been maintained in the highest state of efficiency, the Directors had not felt justified in providing anything for depreciation. After paying the dividend recommended the balance carried forward would be £375, which would be available for dividend in the next account. He then moved the adoption of the report and accounts, and of the declaration of a dividend of 5 per cent.

The motion was seconded by **Mr. G. H. Brougham Glasier**.

The **Chairman**, in reply to a question put by Colonel Young as to the large amount of £7,302 given under the head of sundry debtors for current supplied, observed that it could not be otherwise than large considering the current delivered. On the other side of the account there were sundry creditors, and naturally one was set against the other. The accounts had been made up to December 31st, but the payment for the current sold was due only on December 25th, and it was not possible to collect the accounts for a few weeks. The £7,302 was about one-third of the total amount received, and it represented the increase of business in the last quarter. Most of the money had now been received.

The **Solicitor** (Mr. Fladgate) in answer to Colonel Young, stated that as all the capital had not been taken up, it had been impossible to apply to the Stock Exchange for a quotation for the shares. An application would, however, be made as soon as possible.

The motion having been put to and adopted by the shareholders, the retiring directors, Mr. G. H. Brougham Glasier and Mr. J. Percy Mendoza, were re-elected, and the reappointment of the auditors, Messrs. O. R. Johnson and Son, and the passing of a vote of thanks to the Directors, brought the meeting to a close.

WESTMINSTER ELECTRIC SUPPLY CORPORATION.

On Wednesday the Right Hon. Lord Suffield, K.C.B., presided at the ordinary general meeting of this Company, held at the Eccleston-place central station, Belgravia. The notice convening the meeting having been read by the secretary, Mr. F. Iago, and the accounts having been taken as read,

The **Chairman**, in moving the adoption of the report and accounts, congratulated the shareholders that the Corporation had reached the position of a dividend-paying concern. It would be seen from the accounts that the net earnings were £8,657, to which must be added £3,159 brought forward from 1891, making together £11,816, to the credit of net revenue. Out of that the Directors had paid an interim dividend at the rate of 3 per cent. per annum for the half-year ending June 30, 1892, and they now recommended the payment of a dividend at the rate of 4 per cent. for the past half-year, carrying forward a substantial sum to the next account. The Directors felt, and he was sure the shareholders would agree with them, that the aim of the Corporation should not be to pay large dividends at first, but rather to build up the business on a sound basis, at the same time paying to the shareholders a fair dividend out of the profits of the undertaking. They had written off bad debts which were very small, and no sum fairly chargeable to the revenue of the year had been carried to capital or suspense account. They would observe that the depreciation of plant had been fixed at £2,500 for 1892, which sum the Directors considered a fair amount, looking at the fact that some of the machinery and plant had not been ready at the beginning of 1892, and that it had been maintained in a highly efficient state. The whole of the plant had worked thoroughly well during the year, and the stations for generating the supply were well equipped and working most satisfactorily. When they met at the last meeting, attention was drawn to the fact that the working expenses had been diminished as compared with the preceding year. They would be glad to learn that up to the 31st December last, the expenditure under that head had showed a still greater economy. They would notice that the Corporation had mains laid in 33 miles of roadway, equal to 130 miles of ways, and practically the whole of the principal streets had been laid with mains, with the exception of those in Mayfair. Their policy had been not to lay a main in any street not already provided for unless they saw the prospect of a good percentage on the capital outlay—a policy which had resulted in the capital expenditure in the concern earning a profit. Owing to the unexpected number of lights provided for, it had become necessary to obtain more capital, and the Directors had carried out the resolution passed at the previous meeting for the issue of an additional amount of £40,600 in £100 debentures to the then existing shareholders. In consequence of the progress made, they had been enabled to do that at the reduced rate of interest of 4½ per cent. per annum, instead of at the original rate of 5 per cent., and the whole of the issue had at once been taken up by the shareholders. The development of the business was shown by the fact that whereas on December 31, 1891, the electrical energy sold was equivalent to 62,820 8-c.p. lamps, at the close of last year it had increased to 98.686 lamps, whilst at the time when the report was prepared the equivalent of 102,743 lamps was on circuit, and applications would, it was expected, still continue at a considerable rate. The shareholders would be gratified to learn that the Corporation had been requested to supply her Majesty's Foreign Office with the electric light, and which they hoped would be followed by other large Government offices in and about Whitehall. He was not aware of the exact number of lamps likely to be installed, but it would eventually be considerable, and which they were now prepared to take up. The installation at the Houses of Parliament had been increased by the addition of the supply of current to the House of Lords. With regard to the reduction in the standard charge per unit, they, in June last, came to the conclusion that it was advisable to reduce the price from 8d. to 7d. He thought he was correct in stating that the Westminster Corporation was the first to voluntarily reduce the standard rate. Experience had shown that that was a wise policy, as it not only created a good feeling among existing consumers, but that it greatly increased the number of applications for current. It was found by adopting that course that many consumers added to their existing installations. The Directors had lately had that matter again under consideration, and they felt that the time had now arrived when they must be prepared, in justice to the consumers and without injury to the shareholders, to still further reduce the charge. They had therefore issued a circular, stating their intention to diminish the charge per unit from 7d. to 6d. from 31st March next, with a sliding scale of rebates to very large consumers. The Directors believed, by thus dealing liberally, that they would not only retain their present clients, but also so largely increase the number of applications as to be able to earn a much greater net revenue than at present. He would mention that whilst the Directors had all given their best attention to the interests of the Corporation, they and the shareholders also were greatly indebted to an excellent staff. The engineer-in-chief, Prof. Kennedy, had had a wide experience, which had proved invaluable to them, and he had succeeded in keeping the stations in proper order, and in supplying current without any complaint from customers. Their thanks were also due to their manager, Captain E. I. Bax, and the secretary, Mr. Iago. What with the competition or rivalry of a strong company which left no stone unturned to its advantage, and difficulties of many kinds, it was something to be able to say that they found themselves, after writing off a considerable sum by way of reserve, and carrying forward a substantial amount to the next account, enabled to offer a 4 per cent. dividend for the past half-year; and considering the large increase of current which they were prepared to supply, it was hoped to add to that dividend before long. He then moved the adoption of the report and accounts, and the declaration of the dividend recommended.

Mr. J. Heslop Powell, in seconding the motion, referred to a wall diagram showing the progressive state of the business, month by month, and which demonstrated that whilst the output had been largely increased, the working expenses had not advanced in anything like the same ratio. At the last meeting, when he was in the chair, he had told them that the fog was their best friend, and that was also the case last year. In fact, without the fog the results would not have been so favourable. Consumers had begun to be economical in the use of current, and when other people found that the electric light was cheap, that would lead to further business, and would prove advantageous.

Mr. Finch mentioned that the cost of generating and distributing current amounted to 43 per cent. of the net receipts, whilst in another company in which he was interested the amount was 33 per cent. Then, again, in the case of another company in the neighbourhood of the Strand, the expenses were 42 per cent. of the net income. He hoped that as the net income increased they would be able to reduce the working expenses for generation and distribution. He thought that the Company would derive benefit through the expiration of the incandescent lamp patents.

Prof. Kennedy, in reference to Mr. Finch's remarks, said that the St. James's and Pall Mall Company had only one station, and notwithstanding that the Westminster Corporation were really doing better, because their district was five times as large, and was at present the same output. During the first six months the Company had sold 560,000 units, and the total expenditure was £6,890, whereas in the second half they sold 660,000 units, and received £6,730, or £160 less. It was, however, only during the past six months that they had been running properly.

The motion for the adoption of the report and accounts was then put and carried, and the dividend recommended was declared to be paid on the 1st March.

Mr. R. W. Wallace and Mr. J. Browne Martin, the retiring directors, were re-elected, and Messrs. Cooper Bros. and Co. were reappointed auditors. A vote of thanks to the Directors and staff concluded the proceedings.

CUBA SUBMARINE TELEGRAPH COMPANY.

The forty-third ordinary general meeting was held on Wednesday at 58, Old Broad-street, E.C., under the presidency of Mr. Charles W. Parish.

The **Chairman**, in comparing the results of the half-year with those of the corresponding period of 1891, said there had been an increase in traffic receipts of over £700, the total figures being £20,089. 2s. 8d., against £19,362. 12s. 9d., while there had been an actual reduction in working charges of £235. 4s. 5d. In the London expenses there was an item of £47. 14s for travelling, which did not occur in 1891; this arose from a special journey undertaken by Mr. Keith to Madrid. In the station expenses there was a saving in salaries and wages, and also in the maintenance of the land lines. There was an increase in travelling expenses owing to some changes which had been made in their local staff, but that, of course, was an exceptional item. In August, Mr. Greenwood mentioned that they hoped to clear off on December 31 last the remaining balance of the £48,000 which had been charged to revenue for the Cienfuegos-Santiago 1881 cable. The exact amount of this was £497. 4s. 9d., and this, with the usual half-yearly charge of £1,875, made up the £2,372. 4s. 9d. which figured in the accounts to the debit of revenue. The shareholders were all doubtless aware of the failure of the New Oriental Bank, with which this Company had a deposit of £3,000; and as the Directors had grounds for fearing that the liquidation of that undertaking might not prove satisfactory, they had charged the half-year's profits with £1,500 as a reserve against any loss that might be sustained, but he had good reason for supposing it would not be such a large amount as that. They had been able to carry £4,500 to the reserve fund. He moved the adoption of the report.

The resolution was seconded by **Mr. A. F. Low**, and carried.

COMPANIES' REPORTS.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay, Esq., chairman; Major-General Webber, C.B. (retired R.E.), deputy chairman; Nugent Daniel, Esq.; Emile Garcke, Esq.; Sir George Prescott, Bart. Managing engineer: Frank King, Esq. Secretary: S. J. Cluer.

Report of the Directors to be presented to the shareholders at the annual ordinary general meeting of the Company, to be held at their central station, Draycott-place, Chelsea, S.W., on Thursday, March 2, 1893, at 11 a.m.

The Directors beg to submit to the shareholders the report and statement of accounts for the year ended December 31, 1892. The net profits for the year, after paying debenture interest, amount to £1,336. 2s. 7d., out of which it is proposed to pay a dividend on the ordinary shares at the rate of 2½ per cent. per annum, carrying forward the sum of £176. 10s. 1d. to next year. In considering these results it must be remembered that a large proportion of the Company's capital is in the form of debentures. To meet the necessary increase in capital expenditure, the balance of the first mortgage debentures and £3,700 of the second debentures were issued during the year as the money was required for new works. Important additions have been made to the plant, and various improvements have been effected. The whole of the plant, including the accumulators, is in thorough working order. A very gratifying feature of the accounts is the large saving shown in the consumption of coal. There were 357,162 units of electricity sold during last year, the expenditure on coal being £2,433, as against £2,692 in 1891, when 290,458 units were sold. The total cost of each unit of electricity sold was 5½d. in 1892 against 7d. in 1891. The number of lamps on the Company's mains at the end of 1892 was 34,876, being an increase of 27 per cent for the year. The Directors have every confidence that the accounts for the current year will show still further improvement. The transfer of the Company's area in South Kensington was, subject to the confirmation of Parliament, approved at the extraordinary general meeting held on the 14th inst. The Directors are of opinion that this transfer will be of advantage to both companies. In May last Mr. Frank King was appointed managing engineer of the Company, and the appointment has already produced very satisfactory results. The retiring directors are Sir George Prescott, Bart., and Mr. E. Garcke, wh being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

Revenue Account Year ending Dec. 31, 1892.

Dr.	£	s.	d.	£	s.	d.
A.—To Generation of Electricity.						
Coal or other fuel, including expenses on the same	2,433	1	2			
Oil, water, cotton waste, and engine-room stores	754	3	11			
Wages of men	1,057	8	4			
Repairs, maintenance, and renewals, as under: Buildings, £71. 18s. 2d.; engines and boilers, £303. 5s. 6d.; dynamos, £62. 10s. 8d.; instruments, tools, and sundries, £83. 15s. 10d.	521	10	2			
				4,766	3	7
B.—To Distribution of Electricity.						
Wages at out-stations, meter winding and reading, etc.	358	4	4			
Stores used at out-stations, etc.	45	15	8			
Sundry costs not included in the above	89	1	11			
Repairs, maintenance, and renewals as under: Mains, £27. 6s. 8d.; accumulators and apparatus at distributing station and motor-transformers, £461. 2s. 8d.; meters on consumers' premises, £55. 14s. 5d.	544	3	9			
				1,037	5	8
C.—To Rent, Rates, and Taxes.						
Rents payable	304	0	0			
Rates and taxes	212	10	7			
				516	10	7
D.—To Management Expenses.						
Directors' remuneration	600	0	0			
Salaries of staff	830	5	2			
Salary or commission of collector	90	13	4			
Stationery and printing	61	5	5			
General establishment charges	191	0	9			
Auditors of Company	25	0	0			
				1,798	4	8
E.—To Law and Parliamentary Expenses.						
Law expenses				2	16	0
F.—To Special Charges.						
Insurance	78	6	8			
Wayleaves	5	0	0			
				83	6	8
Balance, being gross profit				4,318	18	10
				£12,523	6	0

Cr.	£	s.	d.
Sale of current (less allowances made)	11,905	8	6
Rental of meters	410	14	8
Transfer fees	0	17	6
Rents receivable and sundry small accounts	206	5	4
	£12,523	6	0

Net Revenue Account.

Dr.	£	s.	d.
Interest on debentures paid and accrued to date	1,843	2	6
Fees to trustees for debenture-holders	100	0	0
Interest on mortgage of freehold, etc. (purchased subject to mortgage)	59	2	11
Renewals fund	1,000	0	0
Board of Trade auditors' fee for auditing accounts of previous years	38	17	6
Bad debts written off	73	13	4
Balance	1,336	2	7
	£4,450	18	10

Cr.	£	s.	d.
Balance from last account	132	0	0
Balance from revenue account	4,318	18	10
	£4,450	18	10

General Balance-sheet, Year ending Dec. 31, 1892.

Dr.	£	s.	d.
Capital account—Amount received	80,585	0	0
Bills payable	2,482	0	1
Sundry creditors	3,809	6	10
Net revenue account—Balance at credit of	1,336	2	7
	£88,212	9	6

Cr.	£	s.	d.	£	s.	d.
Capital account—Amount expended				81,363	18	6
Stores on hand—Coal	£40	0	0			
Oil	8	11	0			
General stores, including work in progress	721	4	6			
				769	15	6
Sundry debtors for current supplied, etc., less bad debts deducted				5,436	9	9
Cash at bankers	£602	18	7			
Cash in hand	39	7	2			
				642	5	9
				£88,212	9	6

BUSINESS NOTES.

Harwich.—The Beacon Hill battery is to be connected by telegraph with a look-out station on the beach.

West India and Panama Telegraph Company.—The receipts for the half-month ended February 15 were £3,011, against £2,635.

Halifax.—The Halifax Town Council have appointed Mr. T. Wilmshurst, of Exeter, as electrical engineer to the Corporation at a salary of £200 a year.

Huddersfield.—Tenders for the supply of main house switches and fuses are required by the Huddersfield Corporation, to be sent in by March 15.

Bristol.—Tenders are invited by the Bristol Corporation for switchboards and transformers for their central and sub-stations. Tenders must be sent in by March 15.

Chelsea Electricity Supply Company, Limited.—The Directors recommend a dividend for the year 1892 of 2½ per cent. per annum on the ordinary shares of the Company.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,233.

Brussels.—The designs for the circular electric railway for Brussels are being brought into shape, although it is hardly expected the railway will be actually carried out just at present.

Windsor Castle.—Large quantities of material for electric lighting are being brought into Windsor Castle, and the wiring is being extended in all directions, including Princess Beatrice's apartments. A larger dynamo and engine have been introduced.

South Wales.—The *South Wales Daily News* is giving a series of articles largely based on that in the enterprising *Belfast Evening Telegraph*, on electrical installations in England, for the benefit of the public of Cardiff, now largely interested in the question.

City and South London Railway Company.—The receipts for the week ending February 19 were £938 against £872 for the corresponding period of last year, or an increase of £66. The total receipts for 1893 show an increase of £895 over those for the corresponding period of 1892.

Telephone Extension.—The National Telephone Company will shortly establish direct communication between Windsor and London, by connecting this town with their Reading and London main line at or near Slough. Numerous Windsor tradesmen have already promised to subscribe.

French Switches.—The *Revue de l'Industrie Internationale* states that the Eclair switch (which is the name given to our old friend, the "Unique" switch, invented by M. Lundberg) has made an immense success in France. This switch is made by MM. D. Poilpré et Cie., who have been forced to put in special machinery to keep pace with the demand.

Old Swindon.—We have already drawn attention to the advertisement last week of the New Swindon Local Board, and this week the Old Town Board have decided to advertise for tenders from companies or firms for lighting the district for a period of seven years from next January. Tenders must be sent in by May 1.

Newbury.—The Gas Committee of the Newbury Town Council reported at the last meeting that a letter from Messrs. Woodhouse and Rawson United, Limited, offering £28,000 and one-fifth of profits beyond 7 per cent. for the gas undertaking and the electric lighting order was considered by the committee to be insufficient to justify further negotiations.

Cambridge.—At the quarterly meeting of the Cambridge Town Council on the 16th inst., the Town Clerk announced that he had received regulations and conditions which the Board of Trade proposed to make under the Cambridge Electric Lighting Order, 1890, for ensuring a proper and sufficient supply of electrical energy. It was agreed to refer the documents to the Electric Lighting Committee.

Powderhall.—On Saturday a sub-committee of the Cleaning and Lighting Committee of the Edinburgh Town Council had before them Councillor Sloan's motion as to the question of providing electric light at the destructor premises at Powderhall, and also supplying a certain area in the immediate district of the buildings. After consideration it was resolved to ask Mr. Murray, B.Sc., for a report on the whole subject.

Helios Lamps.—The International Electric Company, of 34, Aldermanbury, E.C., have just been appointed sole agents for the United Kingdom by the Helios Company, Limited, Köln-Ehrenfeld, for the sale of their well-known arc lamps for direct and alternating current. These lamps were considered by experts at the Frankfort exhibition to be the best shown there. All enquiries respecting the Helios lamps should be addressed to 34, Aldermanbury, E.C.

South African Cables.—The Eastern Telegraph Company announces that telegraphic communication with South Africa is totally stopped owing to the almost simultaneous interruption of the St. Thome-Loanda and Aden-Zanzibar cables. Repairing ships are close at hand in both cases, and communication is expected to be restored in the course of a few days. Meanwhile, telegrams will be sent on by mail steamer leaving Aden for Zanzibar on the 23rd inst.

Sefton Park.—A special meeting of the Liverpool Parks, Gardens, and Improvement Committee was held last week under the chairmanship of Alderman F. Smith, when the draft of the agreement between the Corporation and the Liverpool Electric Supply Company, Limited, whereby the latter have power to lay their mains through Sefton Park instead of under the roads, was agreed to, subject to certain conditions which will prevent the plantations being injured.

Sandgate.—At the monthly meeting of the Sandgate Local Board last week a letter sent by Mr. Sellon, engineer to the electrical tramway, was read. The chairman remarked that it was a matter of deep consideration. If they were to light the town with electric light, it might be a most desirable thing for Sandgate to have an electric railway. Mr. Fynmore remarked that the objection was overhead poles. It was agreed to have a conference with the Hythe Town Council on the subject.

Commissioners of Sewers.—At the meeting of this body on Tuesday, the Commission resolved to advance certain objections to the National Telephone Company's Bill in Parliament. An account was submitted and passed from the City of London Electric Lighting Company, amounting to £4,213, for lighting the public ways of the City up to December last. It was stated that the company were about to advertise districts in which they were prepared to supply the electric light to private persons.

Edinburgh.—The sub-committee of the Edinburgh Town Council in charge of the matter of electric lighting, at a meeting on Monday, discussed the whole subject with the consulting experts, Prof. Kennedy and Mr. Cook, London, and remitted to them to draw up a report as to the best system to be employed in Edinburgh, and as to the question generally. After this report has been received and considered, it will remain for the Town Council to decide whether they will retain the working of the system in their own hands or will entrust it to a company.

Harrogate.—A fashionable Northern watering-place, well off, scattered in district, Harrogate seems to be particularly suitable to an alternating-current supply. We see that a discussion was held at the quarterly meeting of the Town Council last week, and it was resolved to ask the Board of Trade to grant more time to consider the matter. The Council considered the plans and then went into committee. The question, we know, was raised at Harrogate some five or six years ago. It is about time that something more than consideration was done in such a suitable place for electric light as Harrogate.

Pontypool.—Financial affairs with the Pontypool electric company are looking very rosy, according to accounts from that progressive town. Four-fifths of the shares have been taken up, and in all probability will be at a premium. It is estimated (we give the local feeling) that the company has such exceptional chances of success that it will pay at least 10 per cent. from the beginning; ultimately the local authorities will take over the company at a valuation, and each shareholder will get double his money back besides interest. The electric contractor is Mr. Howells, who is also one of the directors and a large shareholder.

Telegraph Construction and Maintenance Company, Limited. The report of this Company states that the accounts for the year to December 31 show a net profit of £51,579, after charging the interest on the debentures. To this sum must be added £57,084 brought forward, making a total of £108,663. From this amount is deducted the interim dividend of 5 per cent., leaving £86,253. The Directors propose a dividend of £1. 4s. per share, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s., per share, or 15 per cent., tax free, leaving £41,433 to be carried forward.

Llandudno.—Mr. John Jones had down for the meeting of the Llandudno Improvement Commissioners: "That the principle of electricity be adopted by this Board: Firstly, as regards public lighting when the Commissioners are in a position to arrange the financial affairs of their gas and water undertakings so as not to cause a serious loss to the ratepayers. Secondly, that an electric tramway be sanctioned within the district of the Commissioners, provided the route and other detailed arrangements are approved of by this Board." The motion was not proceeded with, as the Gas Committee are going into the whole matter with their engineer.

Edison and Swan United Company.—We are informed that the directors have resolved that a payment on account of the dividend of the current year be made at the rate of 3½ per cent. for the half-year on the A shares, with the addition of a payment at the rate of 4·68 per cent. for the half-year in respect of accumulative arrears. This will work out in the following manner: On the 89,261 shares, £3 paid, 3s. 7¾d. per share; on the 5,000 fully-paid shares allotted to the Edison Company, 6s. 0⅞d. per share; on the 12,139 fully-paid shares allotted to the Swan United Company, 4s. and 7¾d. per share. The payment will be made upon the register as it stood on February 21, and the dividend warrants will be issued on March 14.

Dundee.—In view of the public electric supply in Dundee, the editorial rooms and publishing offices of the *Dundee Advertiser* have been equipped with the new illuminant. The central station is not yet ready, but a trial has been made of the fittings in the office with electricity supplied from a dynamo in the printing department. The installation was found to work most successfully. The publishing office, where there are six lamps of 100 c.p. each and several smaller lamps, was especially brilliant, and admiration for the great beauty of the lighting was expressed by many visitors who called to hear the latest news of Mr. Gladstone's Home Rule proposals. The work of erecting the wire was carried out by Messrs. Lowdon Bros., of Dundee.

Extension of South London Railway.—A special general meeting of the City and South London Railway Company was held on Thursday last week at the offices, King William-street, Mr. Sampson Hanbury in the chair, to consider the Bill in Parliament for extending the time for the purchase of lands for, and for the completion of the subway or underground railway authorised by the City and South London Railway Act, 1890. At the request of the chairman, the solicitor explained the Bill. He stated that the time for acquiring land was extended by the Bill to July 25, 1895, and the time for completing the works to July 25, 1898. The other parts of the Bill were formal. On the motion of the chairman, seconded by Mr. Tate, a resolution was passed approving the Bill, "subject to such additions, alterations, and variations as Parliament may think fit to make therein."

Embankment Lighting.—In November last the London County Council approved the recommendation of the Highways Committee as to an electric light installation on the Victoria-embankment and Westminster and Waterloo Bridges, and passed a resolution to include the gardens on the Victoria-embankment. No increase was, however, made in the amount of the estimated cost, £10,000, which was accordingly inserted in the Bill. The committee have been advised that it was insufficient, and the Highways Committee reported that in their estimate for expenditure in the year ending March 31, 1894, they had inserted £5,000 for this purpose. They recommended that an additional expenditure of not exceeding £5,000 be authorised for the purpose of the electric light installation, and that the agent be instructed to arrange for the necessary alteration in the Bill, and this the Council agreed to.

Electric Heating.—Messrs. Crompton and Co. showed an assortment of their new electrical heating apparatus at the president's reception at the Institution of Civil Engineers on Tuesday, the 21st. The room in which this apparatus was working was crowded, and the large electric oven shown in full operation created a considerable amount of interest. Boiling, frying, baking, coffee-grinding, etc., were shown, and many of the members of the institution present were surprised to see that Messrs. Crompton and Co. have brought the application of electric heating to the present stage, as they were under the impression that the apparatus talked of was merely a toy. Messrs. Crompton state that they have received a number of orders for electric ovens, and they have difficulty in meeting the orders for other apparatus which is being used in many parts of the country and abroad.

More Money for the Elmore Companies.—The Directors of the Elmore's Patent Copper Depositing Company, Limited, and of the Elmore's Wire Manufacturing Company, Limited, have issued a joint circular stating that to place the works upon a basis of profit earning from manufactures more funds must be provided, and it is, therefore, proposed to raise £20,000 in the case of the parent company, and £50,000 in the shape of mortgage debenture stock in the case of the wire company. Steps are, it is added, being taken to raise the £20,000 through the company's bankers and solicitors, and the shareholders are asked to subscribe for the £50,000 of mortgage debenture stock. At a meeting of the debenture-holders of Elmore's French Patent Copper Depositing Company, Limited, held at the offices, 64, Cannon-street, E.C., a resolution was unanimously passed allowing the directors to create a further £50,000 of debentures for the purposes of the company's business.

Coastguard Stations Telephone Service.—An early commencement will be made with the establishment of telephonic communication between the various coastguard stations between Peterhead and Fraserburgh, as part of the general scheme which the Government recently resolved to adopt. The new service will connect the Peterhead Coastguard Station, Rattray Coastguard Station, Inverallochy Post Office, Cairnbulg Coastguard Station, Fraserburgh Coastguard Station, and Fraserburgh Post Office, with a call bell in the postmaster's residence for attention on Sundays and after office hours. A vessel is at present on the voyage from London with the necessary materials and stores. The service has to be completed before March 31, and two squads of men, one beginning at the south end and the other at the north end of the line of communication, will be simultaneously engaged in carrying out the work, under the supervision of Mr. Summerfield, electric engineer, Aberdeen.

Telephonic Communication in Manchester.—We understand says the *Manchester Examiner*, that a working arrangement has been entered into between the National and the Mutual Telephone Companies, the two systems which are in operation in Manchester, which may eventuate in the amalgamation of those enterprises. Hitherto the companies have worked independently of each other, but one result of the arrangement they have come to is the establishment of communication between their respective local centres. As there are in the Mutual about 1,300 local subscribers, and in the National over double that number, the importance of the change will be seen. A much wider area of call will be opened out to telephone users in Manchester and the suburbs. Subscribers to the National will be able to ring up anyone on the Mutual list, but members of the latter do not obtain a reciprocal advantage until they have paid the difference between their subscription and that charged by the National.

Malton.—The first installation of the electric light at Malton has just taken place, at the works of the Malton Farmers' Manure and Trading Company, Limited. The company, which was probably the largest consumer of gas in the town, has at the same time started to make its own gas on the Dowson principle. This gas is simply used for driving two gas-engines, which work the machinery employed in the mill, and drive the electric dynamo. The latter, with accumulators, will supply 70 lamps of 16 c.p. each, the accumulators also supplying 20 lamps for an hour. The electric plant has been put in by Messrs. Parr and Gillies, of Haggerston and Buckingham. Work under the new departure commenced recently, and a public test of the light was made on Saturday night, when it was turned on for the first time by Mr. W. H. Rose, J.P., chairman of the Board of Directors. A searchlight of 100,000 c.p., similar to that used in the navy, was at the same time brought into play from the top of the mill, to the no small astonishment of the town and district.

Glasgow.—After many delays, the installation of electric light, which is to supersede the old method of illuminating the streets by means of coal-gas, has been completed, and persons who were afoot late on Tuesday had an opportunity of seeing how the throughfares of the central portion of the city appear under the rays of the latest illuminant. The lamps were switched on only for a brief period for the purpose of testing the installation, and several days will elapse before the light will be in permanent use. The installation was designed by, and carried out under the direction of, Prof. Kennedy, consulting electrical engineer, London. While a portion of the work has been done by contractors, the laying of the pipes and the pulling in of the cables has been carried out by the Corporation employés, under the superintendence of Mr. William Arnot, electrical engineer to the Glasgow Corporation. assisted by Mr. Norman MacFarlane, resident engineer of the station, and Mr. William Lackie, outside inspector.

London Electric.—This Company has just issued to possible consumers an explanatory circular of its system, which states that when properly arranged and controlled it is equally as safe as the low-pressure system, and has the great advantage of giving an equal and regular light throughout the whole of the premises, however distant the furthest lamp may be from the source of supply. An excellent diagram is given of the system adopted, showing the generating station, the distributing stations, the service mains, and, in fact, all the connections down to the lamps, showing that the pressure upon the consumers' premises is reduced to 50 or 100 volts. A list of the streets in which the Company's mains are laid is given, and it is stated that further extensions are about to be made, and that the Company is prepared to receive proposals for supplying within a reasonable distance of the mains already laid. In this circular it is definitely stated that the cost is less than ¼d. per hour for an 8-c.p. lamp. The advantages of the electric light are pointed out in some general remarks as to installation and cost, the circular concluding with valuable suggestions as to conductors, casing, switches, fuses, and other apparatus.

Old Swindon.—At the monthly meeting of the Old Swindon Local Board on Thursday last week, Mr. H. J. Deacon proposed, in accordance with notice given at the last meeting, that advertisements be inserted in the local papers and the *Electrical Engineer* for tenders for lighting the district with electricity. He explained that he had some diffidence in bringing this matter forward, but he did so entirely in the interests of the ratepayers. Electric light was becoming very popular, and also a cheap light. The New Swindon Local Board was taking steps to obtain tenders, and this was a good opportunity for the Old Town Board to take action in the matter. He knew there were members of the Board who were shareholders in the gas company, but he was sure they would give him credit for no personal feeling in the matter, as he was acting for the good of the ratepayers. At Taunton and Bath the electric light was being worked with success. Some 75 to 100 towns had now obtained provisional orders to adopt the electric light. Mr. Deacon quoted from a recent speech delivered by Mr. W. H. Preece, president of the Institution of Electrical Engineers, who was of opinion that electric light would soon become much cheaper, and went on to say that the Board could not be doing wrong in obtaining prices for the lighting. He hoped the shareholders in the gas company who were members of the Board would support the proposition, and thus show a generous public spirit in the matter. Mr. T. H. Deacon seconded the proposition, and the same was carried, only Mr. Balch and Mr. Hall opposing it.

Gas-Engines.—The president of the Midland Association of Gas Managers, Mr. B. W. Smith, of Smethwick, in his inaugural address, gave some particulars of an extensive plant which Messrs. Tangyes has recently laid down to produce gas-engines on their well-known multiple system. They have sent out during last year engines of this type, the total aggregate of which is equal to 5,000 indicated horse-power, to work and test which with the ordinary coal-gas has necessitated the laying of a special 8in. main direct from the outlet of the gasholders. The large meterhouse they have constructed is ultimately intended for four 800-light and one 400-light wet meters; but for the present two of the larger size only are fixed. These are to be used solely for testing and motive-power purposes. Each engine is tested to full power before leaving their works, and consumes from 15 to 24 cubic feet of gas per indicated horse-power per hour, according to size. It is of the utmost importance that the gas should be kept at a perfectly even pressure while testing the large-sized engines. For this purpose the gas company have fixed, for their special use, an 8in. station governor in the same house as the town governor, so that they can at any time when desired increase or decrease the pressure to the requirements without interfering with the district supply. But Messrs Tangyes do not stop at this point. Even with the economical results they have obtained, it is difficult, so they say, for engines over 50 i.h.p. to compete with high-class expansion steam-engines, when the price of gas is more than, say, 1s. 6d. per 1,000 cubic feet. A cheaper gas has therefore to be produced, and to this end they have recently erected a large Dowson producer plant, capable of making gas at about one-quarter the thermal value of ordinary coal-gas for 200 i.h.p., produced from anthracite coal or gas coke. They find in practice that 1,000 cubic feet of this gas can be generated for 3d., including all charges, with coal at 24s. per ton. It, however, requires about 50 per cent. more coke than coal to give the same results, and as four times the quantity of this gas is necessary, it is equal to coal-gas at about 1s. per 1,000 cubic feet.

Maidstone.—A meeting of the Maidstone Local Board was held last week, and considered the report by Mr. Hawtayne on the tric light, which we gave last week. The Mayor, in introducing the scheme, recalled the steps that had been taken. Last year they had several notices of companies intending to apply for provisional orders, and in consequence, to obtain control, the Board obtained their own order. Mr. Hawtayne was appointed as consulting electrical engineer, and his report had been presented. If this was adopted, Mr. Hawtayne was willing to come and reside at Maidstone, at a salary of £300, or if not, he would require to be compensated for his services. Mr. Barker moved the adoption of the report. He thought, as a business matter, it would be well for them to have the light, as Maidstone was the only town of any importance in Kent that had not adopted the electric light. It was not fair to the ratepayers to let a company take it up. They intended to sell electricity to those who wanted it, extending as desired, and not to light the public streets to begin with. Alderman Long seconded, reminding the Board there was such a thing as revoking the order, as had been done at Ipswich, and a company allowed to come in. They were bound to have the light, if not by the Board, by a company, and the Board could borrow money on better terms than a company. Mr. Baker said he was not an opponent of the light, but did not think the scheme advisable. It was suggested the town would take 500 lamps. This would cost £750 to instal, and the supply to the Town Hall would cost twice that of gas. He had interviewed a number of inhabitants, and only two were prepared to take the light at a price equal to 4s. 10d. for gas. Alderman Ellis also, though not an opponent, did not think the scheme would pay. The provisional order did not expire till next July 12 months, and therefore they had time to turn round and see what they were about. He moved "That this Authority does not consider the report of Mr. Hawtayne will justify them in carrying out the scheme, and requests the committee to get information as to the terms on which a company would carry out the order, having special regard to the maximum cost to consumers, and the time for which the contract would run" By doing so they would not run any risk, and would get something definite. Mr. Laurence seconded, and others supported the amendment. Mr. Hawtayne replied to various criticisms, and on the vote being taken 17 voted for the amendment and three against.

Scarborough.—The progress of the Scarborough Electric Lighting Company has been of a very satisfactory nature. The whole of the shares offered for public subscription have been allotted, and last week work was commenced, says a Scarborough paper, on the site of the depôt in Seamer-road. The plans for the building have been prepared by Messrs. Hall and Tugwell, while Mr. William Peacock has secured the contract for the building. This will include boiler-sheds and engine-houses of sufficient size and capability to accommodate seven engines of 1,000 h.p. each. There is a clause in the contract that the engine-rooms shall be ready for the engineers to take possession of by May 10th. In addition to this work there has to be constructed a chimney of 150ft. in height, and this is to be complete, according to present arrangements, by the middle of June, in time for the engineers to give the machinery a final trial by the end of that month. Meanwhile the work of laying the cables (for which every arrangement has been made) will be carried on apace. These will be drawn through 6in., 4in., and 3in. pipes, and will, it is anticipated, be in full working order by the end of June, so that the light can then be switched on. The main cable will be laid along the Valley-road, proceeding by means of the plantation to the rear of The Crescent, thence along Huntriss-row to Westborough, along Newborough, up St. Nicholas-street round by the Grand Hotel, and so on back to the works. The whole of the compulsory area will be at once lighted, though many applications for lights have been received from the South Cliff and other parts of the town The engines employed will be of Messrs. Parsons's (of Newcastle) manufacture, and the system used will be in every respect identical with the Newcastle arc Although at first sight the site selected seems a little out of the way, its adoption has been the result of deep thought and careful consideration by the directors. The spot at first selected on the Sandside was early found to be too small to allow of the extensions which it is hoped will early be necessary. The use of sea-water for condensing purposes was afterwards believed to be open to many objections—the principal of which were the possible silting up from sand and the backwash which would have to be contended with. There was in addition the work of cutting through the walls—a task which might have meant a big expense. The second site considered was also held to be too small, and then the Seamer-road was fixed upon. This has the advantage of being next the railway siding, so that coal can be easily obtained. It is of two acres extent, and the plans provide for the construction of a lake of one acre in size and 4ft. deep, which will, it is hoped, provide by natural drainage a storage of water sufficient for all condensing. Before many days have elapsed the work will be in full swing. The directors are hoping, as stated above, to have everything in order in time for the season of this year.

London County Council.—The Highways Committee of the London County Council reported on Tuesday that they had considered the undermentioned electric lighting schemes with reference to which application has this session been made for provisional orders: (*a*) Promoted by local authorities: Islington electric lighting, Hackney electric lighting, Hammersmith electric lighting, Poplar district electric lighting; (*b*) Promoted by companies: Islington electric lighting, St. Mary, Islington, electric lighting. They have represented to the Board of Trade that in considering the application relative to the parish of Islington, preference should be given to that of the Vestry as the local authority, and that the applications of the County of London Electric Lighting Company and of the Holloway Electricity Supply Company should not be acceded to. With regard to the four orders promoted by local authorities they have submitted to the Board suggestions for some few amendments which appear to be necessary to make the orders accord with previous legislation. In the case of the Hammersmith order they have also suggested that words should be inserted to except Hammersmith Bridge from the area of supply. The Board of Trade has intimated that this exception will be made, and that certain of the suggested amendments have been made in the order. The other amendments are unimportant. They also report with reference to the Kensington and Knightsbridge and Chelsea Electric Lighting Bill, that this Bill provides for the transfer to the Kensington and Knightsbridge Electric Lighting Company of the undertaking of the Chelsea Electricity Supply Company, under the South Kensington Electric Lighting Order, 1889. It is not proposed that the Chelsea Company's transformer station at 101, Egerton-gardens-mews shall be included in the transfer; and the committee think that it should be made clear that the company shall not, except under proper restrictions, retain any right to break up streets in order to obtain access to this station. They accordingly suggested to the Parliamentary Committee that a clause with this object should be inserted; and the Council on the 14th inst. ordered a petition to be presented against the Bill. The committee have considered notices from the Kensington and Knightsbridge Electric Lighting Company of an extension of mains in South-place, and from the Electricity Supply Corporation, of intention to lay mains across the Strand, along Adam-street, across John-street and along Adelphi-terrace. To these works, which are of the same description as those previously approved by the Council, they consent. The House-to-House Electric Light Supply Company has applied, under the Board of Trade regulations and conditions for securing the safety of the public, for permission to stop the supply of electricity for one hour per day for the purpose of testing mains and apparatus. This request appears to be reasonable and the committee recommend that permission be given to the House-to-House Electric Light Supply Company to stop for one hour per day the supply of electricity, on condition that the time selected for so doing shall in each case be subject to the approval of the Council's chief engineer, and that arrangements shall be made to prevent as far as possible the supply being cut off from more than one district or block at one time, and that when required the company shall give to the Council's chief engineer particulars of the results obtained by the testing of the mains.

Leicester.—A special meeting of the Leicester Town Council was held on Monday to receive a report on electric lighting from the Gas Committee. The committee report that in July last they issued advertisements inviting electrical engineers to submit schemes and tenders for the works and mains necessary to supply the above-mentioned area. Seventeen firms responded to this invitation, and 25 schemes were submitted. These schemes and tenders have been very carefully dissected and reported upon by Mr. Colson, and fully considered by a special sub-committee, who have, in connection with the consideration of this question, visited many of the most important electric lighting stations. The committee now recommend that the scheme of the Brush Electrical Engineering Company be adopted, subject to such modifications and improvements as may hereafter be determined upon, and that their tender at the sum of £26,977 be accepted, which tender does not, however, include the cost of buildings. It will be necessary before the works are proceeded with that the consent of the Local Government Board should be obtained to the utilisation of land adjoining the Aylestone-road Gasworks as a site for works, and also for the Board's sanction to be obtained to the borrowing of £50,000 for the execution of works and the erection of buildings, and your committee recommend that a memorial be forwarded to the Board without delay. The probable demands for supply have been considered in recommending the scheme now submitted, and if it be adopted by the Council your committee will in due course report fully upon the scale of charges to be made for the supply of electricity. The Mayor (Alderman Underwood) presided, and there was a full attendance. Alderman Lennard, in moving the adoption of the report, said that the matter had been under consideration for two years. The committee were of opinion that the time had now come when the Council should move in the matter, as they believed there was very little margin left for further improvements in the science of electric lighting. Of the 14 tenders sent in their engineer selected two, that of the Brush Company and the other presented by Messrs. Ferranti, and after full investigation the committee decided by a considerable majority to recommend the former, on the ground that it not only best met their requirements, but would prove also to be the cheapest system. The cost would be extended over 30 years, and he went into figures to show that the introduction of the new light would not add a penny to the burden on the ratepayers. Councillor Billings seconded. Councillor Clarke adversely criticised the scheme proposed, and contended that the tender of Messrs. Ferranti ought to be accepted, on the ground that it was cheaper, and would prove more workable. A somewhat heated discussion ensued on a proposal to refer the matter back to the committee. Alderman Lennard complained that a gentleman whose tender had been rejected had been canvassing among the members of the Council, and had put forth incorrect figures, and that Mr. Clarke's son had been accompanying that gentleman, and if such a course of action was allowed to continue there would be an end to all pleasure in doing the work of the Council. Councillor Marshall characterised some of Alderman Lennard's statements as false, and contended that they ought to have the plans of the two systems equally before the Council. Councillor Clarke warmly denied that he had any personal interest in the adoption of the Ferranti scheme, but claimed that it was the superior one. Alderman Lennard said he would have no objection to the discussion being deferred if the Council would prohibit canvassing among the members in the interval. Ultimately it was agreed that the discussion be adjourned for a month, on condition that canvassing or touting by any contractor would be held to be a disqualification of his scheme.

Bradford.—On Tuesday an enquiry was held at the Bradford Town Hall, by Major-General C. Phipps Carey, R.E., one of the inspectors of the Local Government Board, into the application of the Bradford Town Council for the issue of a provisional order giving the Council power among other things, to borrow £30,000 for purposes of extending the electric lighting. The application was supported by the town clerk and Mr. T. Schofield and Mr. S. W. Baines, of the Electricity Supply Department. It was stated that originally when the Council obtained powers for supplying the electric light the borough was divided into two portions. It was made compulsory upon them to supply a small portion of the centre of the town, but permissive to supply other portions of the borough. For some time consumers stood aloof to see whether the installation was a success or otherwise, but now, finding that it was a great success, a great many demands were made for the light. The Council had decided to extend their area of supply in all directions from the centre of the town, and the loan was wanted for the expenses of the extension. Of the total sum £9,550 was to be spent on buildings, and the bulk of the remainder on machinery and plant. In reference to the extension of the business it was stated that there were now 250 private consumers. There was no intention of utilising electricity for the public street lamps, as those were supplied with gas by the Gas Committee free of cost. At one time, the Town Clerk said, the Gas Committee was making a profit on gas of £30,000 a year, but they preferred to supply gas for nothing for the streets and charge lower prices, making the profit less, but the public service greater. The inspector pointed out certain risks in regard to the electric light, and suggested that it might have been better that it should be in the hands of a company. The Town Clerk said that was just what the Corporation did not wish. If a private company had a hand in it the company was king of the town, but the Town Council preferred that it should itself be that. Besides, the Corporation thought it could work the electricity works more economically. The management expenses were nothing, beyond salaries of officials. If a private company had the matter it opened pavements at its own sweet will, causing considerable expense, whereas the Council made its work fit in with other work they had in hand, and avoided breaking up roads as much as possible. Mr. Baines pointed out that the works were making a profit, and the charge was only 5d. per unit of electricity. The Town Clerk added that at Leeds, where a company was setting up an installation, the charge was 8d. per unit. Mr. W. W. Wilkinson, a ratepayer, intimated that he opposed the application. He said he approached the matter from a ratepayer's point of view. By the adoption of electricity ratepayers had already lost over £5,000, and this loss was imposed upon the general body for the questionable advantage of not more than 1 per cent. of the ratepayers. He asked the Local Government Board not to sanction the loan. He complained that accounts were not published. If the accounts were available, he believed it might be proved that the loss was much more than the £5,000 he had mentioned. The borough accountant, Mr. Thorpe, said it was not true that the accounts were not published. He produced a volume giving detailed accounts of the Corporation's working in every department. Mr. Wilkinson said he had not seen that book. Mr. Thorpe said that was not his fault. A copy was sent to every branch of the free library and to the Local Government Board. It was not true also that a loss was incurred on working. The result of the transactions last year was a net profit of over £1,300 after paying not only interest, but sinking fund on the debt. The result of the whole four years' working of the electricity department was a net profit of £289. 15s. Mr. Wilkinson said that nothing had been written down for depreciation. Mr. Baines said the opinion of experts was that nothing need be written down for depreciation, because the works were kept up to value out of revenue, and were, indeed, daily becoming more valuable. Besides that, the sinking fund was paid. The Town Clerk said that Bradford lived by trade, and anything which assisted trade was a benefit to the town. The enquiry then passed to other matters.

Water Power at Cardiff.—With reference to the lighting of Cardiff, Mr. Sydney F. Walker writes to the *Western Mail* advocating the use of the town water supply power for electric light. Taking the available fall of 150ft. (out of 900) and the daily supply of four million gallons, he calculates the energy that could be supplied. This as a first supply; but as there are three falls of reservoir water three-turbine installation could be made, with long-distance transmission. He thus deals with the practical difficulties of the undertaking: "The water would hardly be running into the town at all hours of the day and night at the same rate. Further, it is probable that 16 hours would be the limit of the actual flow of water for practical purposes, while it will be important, if the electric light is permanently established, that there shall be an all-night service. On the other hand, the lights may be required at any moment of the day or night, and the current must be present at all times; the bulk of the lights are only required for about two hours during the day in the depth of winter. One of the greatest difficulties that electricity supply companies have to deal with is the fact that a large portion of their machinery is idle for 22 hours out of the 24. Putting these two peculiar features together, however—the 16-hours' variable flow of water and the two [illegible] heavy requirements of the electric light—it is not dif[illegible] formulate a practical scheme for utilising the [illegible] the water. Four million gallons per day give 250,000 gallons per hour for a 16-hours day, and this, with a fall of 150ft., gives approximately 190 h p. This, however, is the total energy of the water, and from it would have to be deducted the charges for friction of the water itself in the pipes, for conversion into mechanical energy in the turbine or waterwheel, and for conversion into electrical energy in the dynamo, for the friction of shafting, belts, etc. The electrical currents furnished by the dynamos would be used to charge secondary batteries, and there would be a further loss here for conversion and reconversion, so that out of the 190 h.p. only 100 h.p., or possibly less, would be available in the form of electric currents for furnishing light, heat, or power. But this 100 h.p. would be available for 16 hours, giving us 1,600 horse-power hours. If we set aside 400 horse-power hours as sufficient for the 22 hours during which the number of lights burning is small, we have 1,200 h.p for the remaining two hours, or 600 h.p. for each hour of maximum load, giving us sufficient current for 7,200 lamps of 16 c.p., or 12,000 lamps of 10 c.p., or their equivalents. The power obtained at Llanishen would be double these figures, giving us with that taken from just outside the town, current for 21,000 lamps of 16 c.p., or 36,000 lamps of 10 c.p., or their equivalents. Now, as to saving, I have given the number of 10-c p. lamps because the London companies appear to work to this unit. Each 10-c.p. lamp consumes, approximately, 20 supply units per annum, 20.000 watts for the hour, or the equivalent, and each unit costs, approximately, 1d. for coal. The cost of coal varies, of course, but this is a fair average figure and is not excessive. Taking, then, 12,000 lamps of 10 c.p., consuming 20 units each per annum, we have a saving of 240,000d., or £1,000, per annum; or, with the Llanishen supply added, £3,000 per annum. The cost of laying down the apparatus would be about the same as with steam-engines, or possibly more, but the cost of attendance should be less, and there should be a saving in the matter of such charges as hauling and handling the coal. It should be noted, however, that if my figures are correct, the power to be obtained just outside Cardiff would be sufficient for considerably more lights than Mr. Massey has provided for in the £32,500. Another point that should also be noted is that it would not be possible, with our present knowledge, to use alternate currents and transformers, as Mr. Massey is intending under the present scheme. Up to the present no practical method of charging accumulators with alternate currents has been devised. Putting the amount saved in another form, £3,000 per annum would pay the interest at 3½ per cent. on £85,000, or it would pay 9¼ per cent. on the £32,500 that the Corporation are about to spend." Mr. W. H. Massey, in reply, writes that Mr. Harpur himself had to consider this very point of the utilisation of water power more than two years since, and also took into account the question of refuse destructors and other apparatus which, besides water power to some extent in the future, may be embraced in the present scheme, the Lighting Committee approving only after they had satisfied themselves thoroughly that the real interests of the ratepayers had been kept in view all the time. As to the charging of accumulators by alternate currents, Mr. Massey adds: "Towards the end of his letter Mr. Walker says: 'Up to the present no practical method of charging accumulators with alternate currents has been devised.' But he is quite wrong. The possibility of doing these things has long been recognised, and, as a matter of fact, they are now done daily."

PROVISIONAL PATENTS, 1893.

FEBRUARY 13.

3146. **Improvements in diaphragms for telephones.** George Lee Anders and Walther Kottgen, 10, Jeffreys-square, London.

3152. **An improved electrical pendulum indicator.** Ebenezer Beal, 167, Highfield-road, Seedley, Manchester.

3200. **Improvements in fixing electric conducting wires to the insulators supporting same.** Paul Rudolf Schomburg, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3210. **Improvements in primary batteries and in miners' and like portable lamps.** Samuel William Maquay, 55, Chancery-lane, London.

FEBRUARY 14.

3225. **Improvements in and relating to telephonic transmitters.** Alexander Marr, 70, Market-street, Manchester.

3274. **Improvements in electrical transformers, and in boxes or casings therefor.** Walter Claude Johnson and Samuel Edmund Phillips, 28, Southampton-buildings, Chancery-lane, London.

3278. **Improvements in electric lanterns and reflectors therefor.** Ernest Berry and Frederick Harrison, Lyric-chambers, Haymarket, London.

3285. **Improvements in electric signals.** Frank Hawthorne Clarke, 97, Newgate-street, London. (Complete specification.)

FEBRUARY 15.

3346. **Improvements in the application of electric motors for driving sewing and other light machinery.** Frederick Brown, Fairyfield, Highgate-road, Walsall.

3376. **Improvements in direct-current dynamo machines.** *Joseph Sinclair* Fairfax, 433, Strand, London.

3387. **Improvements relating to the utilisation of electricity for heating purposes, and to apparatus therefor.** John Robert Quain, 11, Southampton-buildings, Chancery-lane, London.

3398. **An improved insulating material for electrical purposes, and method of preparing same** Adolf Gentzsch, Julius Goldschmidt, and Etienne Ritter von Scanavi, 55, Chancery-lane, London.

3402. **Improvements in electric meters.** William Clark, 53, Chancery-lane, London. (The firm of Hartmann and Braun, Germany.)

3412. **Improved means for transmitting telegraphic signals through submarine and like cables.** Alexander Muirhead and Henry Alfred Charles Saunders, 124, Chancery-lane, London.

3413. **Improvements in recording instruments for electric telegraphs.** Alexander Muirhead and Robert Henry Edgar, 124, Chancery-lane, London.

FEBRUARY 16.

3461. **A new or improved writing-desk and paper-roll holder combined for telephones.** Carl Gustav Nestler, 34, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3470. **Improvements in electromotors and dynamos.** John Augustine Kingdon, 29, Marlborough-hill, London.

3477. **Improvements in constructing and connecting galvanic elements.** Henry Nehmer, 4, Grafton-street, Gower-street, London.

3488. **Improvements in telephones.** Sir Charles Stewart Forbes, Bart, 21, Finsbury-pavement, London.

FEBRUARY 17.

3572. **Improvements in printing telegraph receiving instruments.** John Edward Wright, 45 Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103, November 16, 1892, being date of application in United States.) (Complete specification.)

3573. **Improvements relating to the extraction of metals by means of electricity, and to apparatus therefor.** Eduard Taussig, 45 Southampton-buildings, Chancery-lane, London.

FEBRUARY 18.

3590 **Improvements connected with electrical conductors and their insulation.** Ernest Payne, 39, Victoria-street, Westminster, London.

3666. **Improvements in and relating to electricity distribution.** William Lowrie, 117, Bishopsgate-street Within, London.

3675. **Improvements in and connected with telephone transmitters.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

18646. **Electric motors, etc.** Chitty.

22037. **Printing telegraph receiving instruments.** Lake. (Wright.) (Second edition.)

22785. **Dynamo-electric machines.** Pyke and another. (Second edition.)

1892.

1880. **Electric sound-producing apparatus.** Woakes.

4779. **Electric arc lamps.** Rathbone and Houghton.

5161. **Telephone cabinet.** Vost and Fisher.

5526. **Producing electric flashes.** Siemens Bros. and Co., Limited, and Baily.

6253. **Electric railways and tramcars.** Churchill.

9496. **Telephones.** Forbes.

12468. **Electricity meters.** Edmondson and Oulton.

20308. **Incandescent electric lamps** Applegate.

23232. **Secondary batteries.** Johnson. (Michel.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	$2\frac{7}{16}$
City of London	—	12½
Electric Construction	10	2¾
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4⅛
London Electric Supply	5	¾
Metropolitan Electric Supply	—	6¾
National Telephone	5	$5\frac{5}{16}$
St. James'	—	8
Swan United	3½	$3\frac{5}{16}$
Westminster Electric	—	5⅞

NOTES.

Institution.—The discussion on Mr. Mordey's paper will be continued next Thursday, March 9th.

"De Magnete."—The translation of Gilbert's "De Magnete" is now published by Messrs. Wiley and Son, of New York, price 4dol.

Electric Locomotives.—The building of large electric locomotives is not lagging behindhand, for we are told by the Westinghouse Company that they are building a 300-h.p. locomotive.

Death.—The death is announced, at the age of 75 years, of Dr. Norven Green, a well-known figure in American electrical circles, the manager of the Western Union Telegraph Company.

Paddington.— The directors of the Metropolitan Electric Supply Company will hold a reception to-day to meet the members of the Paddington Vestry on the occasion of viewing the company's new station at Amberley-road, Harrow-road, Paddington.

Maxwell's Theory.—M. Cohn has found that the speed of electric propagation in water is 8½ times slower than in air, and 8·5 is precisely the value of the index of the refraction of water as found by M. Ellinger. This is another verification of Maxwell's theory.

Erratum.—In the description of Lord Kelvin's engine-room wattmeter, p. 202, a curious error is to be found. "The potential coils are said to be artistically arranged." Of course, "artistically" should read "astatically." Printers will be funny, but we should prefer the fun in our comic contemporaries.

Honolulu Cable.—The project of laying a cable between Honolulu and California, which has been long under consideration, is now revived by the proposal to annex Hawaii to the United States. The situation is discussed at length by the New York *Sun*, quoted in the *Western Electrician* for 18th ult.

The Telegraph.—An interesting lecture was delivered at the Technical School, Bolton, on Monday last week, on "The Electric Telegraph," by Mr. W. Lynd, of London. The land and submarine telegraphs were illustrated, and the loud-speaking telephone experimentally demonstrated. The lecturer received a hearty vote of thanks.

Excursions to Chicago.—The Council of the Society of Arts, acting as the Royal Commission for the Chicago Exhibition, have arranged with Messrs. Cook to organise a special private excursion to Chicago for members of the Society of Arts from July 22nd to August 23rd. The cost will be £65, and the number of passengers will be from 25 to 100. Members may take two of their family at full fare. Detailed particulars can be had from the Society of Arts.

Wiring Formula.—The following formula is given by a Chicago firm for the benefit of those who desire a simple method of calculating leads for parallel distribution:

$$C\,M = \frac{21{\cdot}21 \times C \times D}{E}.$$

Where C M = area of wire in circular mils, 21·21 = constant for 2 "mil" of copper wire, C = current in amperes, D = distance in feet to lamps, and E = volts loss in conductor.

Society of Arts.—Prof. Chandler Roberts-Austen will commence a course of three Cantor lectures on "Alloys" at the Society of Arts on Monday next, the 6th March, at 5 o'clock. The remaining lectures will be given on the two following Monday afternoons at the same hour. The first lecture will deal with analogy of alloys to solutions; importance of studying the behaviour of alloys while they liquefy and as they "freeze"; experimental methods adopted in conducting the investigations.

Death.—The death is announced, at the early age of 34, of Mr. Geo. B. Prescott, jun., a well-known American electrical engineer. He was an assistant of Edward Weston in pioneer work on dynamos and lighting, and became a frequent contributor to the technical journals, besides being the author of a set of copper-wire tables. He was a member of the American Institute of Electrical Engineers, and one of the Standard Wiring Table Committee of the institute, the report of which embodies much of his research.

Directo-Alternating Transformer. — Sir David Salomons exhibited his rotating disc transformer again last Friday before the Royal Institution. We understand that another of this directo-alternating transformers is on hand, to give four amperes at the frequency of a million alternations per minute. The oil transformer used with this will transform the current to 100,000 volts, with corresponding diminution of current. Some interesting researches on high-frequency currents are being carried out by Sir David Salomons on the lines indicated by Mr. Tesla.

Solder for Aluminium.—A new soldering metal for aluminium has been prepared by Mr. Alexius Rader, of Christiania, Norway. It consists in combining cadmium, zinc, and tin mixed in substantially the following proportions: Cadmium, 50 per cent.; zinc, 20 per cent.; tin, the remainder. The zinc is first melted in any suitable vessel, when the cadmium is added, and then the tin in pieces. The mass must be well heated, stirred, and then poured. This soldering metal can be used for a variety of different metals, but it is specially adapted for aluminium.

Portable Electric Lantern.—A portable electric hand-lamp, invented by a Russian engineer, is being taken up by the Russian officers for inspection of trenches and mines at night. It is in the form of a tube 2ft. 6in. long, the interior being made of tin. Tiny cells, forming a battery, are superposed in this tube and connected together in a special manner. The power of the light is considerable, and the form is found convenient. The lamp is enclosed in six plates of glass at the top of the tube, and the brilliancy is regulated by a screw at the lower end. It is probable that the lamp may be adopted by the Russian Government.

Papers.—The meeting at St. Louis of the National Electric Light Association promises to be rich in interesting papers. Prof. Forbes promises to attend the meeting, and intends to prepare a paper to read there. Mr. Tesla will give a lecture with experimental demonstrations of high-frequency current; and Mr. Bradley, whose name is well known in connection with three-phase currents, will have a paper on "Long-Distance Transmission of Power." Mr. Stillwell will investigate "Under What Conditions Water Power is Economical?" a very practical question, and, of course, "The Incandescent Lamp," by Mr. Townley—now a very live topic—will be eagerly discussed.

Communication with Lightships.—The following expression of opinion has been forwarded to the Postmaster-General from official bodies at Deal, Dover, and Ramsgate: "We beg leave to submit that there should be connecting links of communication with the shore throughout the entire system of the Kentish and neighbouring lightships, and, above all, the East Goodwin and South Sand Head lightships should be provided with the means of electric communication similarly to that recommended by the Royal Commission respecting the North Sand Head light.

We respectfully, but firmly, urge that any scheme short of fulfilling the complete requirements will signally fail to remedy the evils so universally admitted to exist."

Dynamo Brushes.—A new dynamo brush has been introduced by Messrs. Hersch and Meminger, of Milwaukee, possessing practical advantages over the usual forms, as a test extending eight months has shown. The brush looks like a piece of inch board. The inside is composed of numerous strips of copper, which bear on the commutator and form the conductor. Between the strips is a mixture, the principal ingredient of which is graphite; there is a gritty substance, which tends to keep the commutator clean, while the graphite lubricates it. The brush does not wear very fast, and it does away with all noise. The brush is particularly meant for motors and electric cars, and the Milwaukee cars are so fitted. It seems a good idea.

Efficiency of Transformers. — The problem of economic transformer distribution will be definitely solved, say its advocates, when a transformer is put on the market having an efficiency of 90 per cent. on one-tenth load. Well, this condition is satisfied, if what we hear is true, by the new Westinghouse transformer now being made for ordinary use in America. The tests shown to us of a 13-kilowatt transformer are as follows: Full load, 97·715 per cent.; half-load, 97·4; quarter-load 95·84; one-tenth load, 90·77; and one-hundredth load, 50 per cent. These figures speak for themselves. The drop in voltage between full and no load is 2 per cent. There is no great peculiarity in the transformer, save that of general careful design.

The Three-Wire Patent.—It will be interesting to a number of persons, debating in their own minds as to how the recent decision in the Hopkinson three-wire patent affects them, to learn that a large corporation station using secondary battery distribution on the three-wire system, has decided to pay the royalties. This is at Dundee, and although the patent is specially applicable to the distribution from dynamos, it will be difficult to hold it is not to include the distribution from secondary batteries. At any rate, so the legal and technical advisers to the Corporation consider, and the royalties have been paid. The amount which is being claimed is not excessive—£2. 10s. a year per ton of copper laid; and it may be remembered that the patent right only extends to 27th July, 1896.

Electric Ice Cars.—It is evident that traction could be carried on with smaller locomotives if the friction was reduced. Whether any sane engineer could prove that it would be economical to freeze the railway lines and run the cars on skates, is to be doubted; but it is certain one gentleman is going to try to prove this. Mr. Erasmus H. Craw is the very Yankee name of the promoter of a very Yankee scheme, who surprised the New York City Rapid Transit Commissioners by this proposition. His tracks would consist of flat iron pipes carrying a freezing mixture, and the motive power would be high-pressure water. The speed desired is 80 miles an hour, and it seems the scheme has been tried at a fair at New Orleans with success, though in this case the influence of gravity down a decline was used as propelling force.

Twin Carbons.—The cost of trimming arc lamps is a serious item in all stations running public electric lighting. If this cost of labour could be reduced to half or one-third, nothing would better please managers and directors. This desirable result is the object of an invention by Mr. Jas. McLaughlin, of Chicago, who makes his carbons of the shape of a tuning-fork. Placed opposite another pair of twin carbons, it is seen the current in an arc lamp has two paths. The two legs of each twin carbon are sufficiently far apart to prevent jumping across of the arc, and first one leg burns away, and then the other, according to which arc has least resistance, the feed being as usual. The base of the carbons are made to fit the sockets at present in use. It is claimed that the time of burning the carbons is two, three, or four times as long as the present single rods, and these compound carbons can be made not only double, but in bunches of three or four if desired. It would be interesting to see the experiment tried in this country.

Incinerators.—We are told that the engineer of the Madras Electric Tramways has visited the Gorutcha incinerator at Calcutta, and has been so struck with its steam-raising power that he has decided to apply the same principle to Madras, and utilise the waste heat for the boilers. The following considerations are brought forward by the *Indian Engineer* to direct attention to this departure. One pound of straw burnt in a suitable furnace has been known to yield 4lb. of steam, and assuming town refuse possesses only the eighth part the calorific power of straw, the combustion of one ton of refuse should produce nearly 18 h.p. for 24 hours. As 12 tons per 24 hours is not an unusual capacity for an incinerator, 216 h.p. would be available with a perfectly-constructed furnace. If only half this were realised, a constant source of over 100 h.p. will be available at little greater expense than the up-keep of the boilers and engines. It is not likely that this can be done with the present incinerators in India, but the possibilities are worthy the attention of engineers.

Earth Currents.—The systematic study of earth currents is at last to be undertaken in France. The only observatory in Europe that takes notice of the earth currents is that at Greenwich. In France, in 1883, M. Blavier, an official in the telegraph service, kept a register of earth currents for a period of six months, but since that time nothing has been done. It has been impossible to use the State telegraph lines for these researches, and M. Mascart has now induced the Administration of Posts and Telegraphs to construct three lines about 10 miles long, which are connected to the observatory of the Parc Saint-Maur. One of these lines runs north and south, the second runs east and west, and the third goes round the observatory in a closed circle for the purpose of studying the vertical component of the earth currents. The ends of the first two are connected to earth, and the readings of delicate galvanometers will be taken systematically by photographic means. M. Moureaux, director of the observatory, will have charge of the researches, which, it is expected, may lead to useful results when compared with the variations of the earth's magnetism and in explanation of this phenomenon. It is hoped that the example of the French observatory will be followed in other magnetic observatories in districts as wide apart as possible.

Edison Lamp Patents.—The Goebel lamp defence has failed, and the injunction against the Beacon Lamp Company brought by the holders of the Edison Company has been granted by the Court. The Edison patents have therefore come triumphantly out of the sudden avalanche of affidavits, though we are told the defendants mean to carry the case on with further evidence to higher courts. The defence broke down on the Goebel lamp No. 4—a very perfect horseshoe filament lamp with a long glass globe. There was much doubt thrown on the date of the lamp, though it was not shown that the other so-called "hairpin" lamps were not very early specimens. But the legal adviser to the Edison Company maintained successfully that Goebel simply brought from Germany the old ideas of Starr of a carbon pencil enclosed in a Torricellian vacuum, and probably constructed lamps after this model, according to the imperfect knowledge of the time; but to think that at a sudden bound he passed from Starr to Edison passed credulity. It was impossible that the lamp No. 4, with platinum wires, horseshoe filament, and a good vacuum, was constructed before 1872; there was nothing to prove this, and other things showed it to be untrue. As we said, the Court accepted this view, and, at any rate for the present, Goebel follows Drawbaugh into the limbo of great patent case failures.

Testing Alternators.—Mr. Mordey's method of testing alternators by inserting a single coil, running the machine with this one coil, and then multiplying up for the total result, has the advantage that it can be employed before the whole machine is complete. "I have used this method," said Mr. Mordey, by way of parenthesis to his paper, "in testing machines when I have not been quite certain whether the calculations were correct. The machine is run with one coil only before the rest are constructed, and multiplying by the number of coils gives the required total output." With regard to running alternators in parallel, Mr. Mordey's remarks are written in the form of directions to the engineer-in-charge, as sent out for stations where parallel running is desired. The regulation is done at the valve of the engine for the most part, and in regulating the speed the blinking of the lamp on a differentially wound transformer is a very exact measure of the equality of speed. The blinking indicating the variation of period of one in many thousands, and occurring once in a few seconds or minutes, allows the speed to be regulated with the greatest nicety. The length of time during which parallel running of alternators has been regularly accomplished and the extent to which it has already been carried out will cause much interest, if we may judge by recent utterances, among the alternating-current engineers on the other side of the Atlantic.

Alternating-Current Meters.—The requirements for an alternating-current meter pointed out by Prof. Fleming at his recent lecture, are these: A fair accuracy—or rather a small known inaccuracy which remains constant—facility of fixing, moderate cost, and, lastly, the quality of not altering by change of temperature. The first quality, accuracy, is achieved in electric meters to a far greater degree than in gasmeters. Within 1 per cent. is certainly fair accuracy, and this is often surpassed, but the important point is that this error should not change at different times or at different loads. Facility of fixing includes general hardiness of constitution—if delicate levels are required or solid posts are to be provided the cost of labour becomes great. The cost is naturally of first importance—some excellent meters for measuring up to 20 lamps have been designed and tested, but would cost £25 each to make—the question of the amount of hire would a 20-light customer be likely to pay for a meter evidently not crossing the inventor's mind. The last quality, of not changing in accuracy by reason of rise or fall of temperature, is an exceedingly important point, likely to be overlooked by some designers. The resistances used should be of manganin, or some other material whose resistance does not alter with change of temperature. When it is remembered that a change of 40deg. may often occur in cellars of houses according to the season, an alteration in the accuracy of the meter of 10 or 15 per cent. might occur if the resistance of copper wire were included in the metering arrangements.

Batavia Exhibition.—We have received a circular and letter from Messrs. John Birch and Co., merchants' engineers, 10 and 11, Queen-street-place, London, and 40, Chapel-street, Liverpool, with reference to the approaching exhibition in Batavia in July, and we are asked to interest electrical engineers in the project. We are pleased to refer to the subject, but must leave electrical engineers to consider themselves whether the expense of exhibiting is likely to pay them. The question is one of pounds, shillings, and pence, and if an exhibition in East or West can be shown to pay, manufacturers will exhibit, never fear. German manufacturers think it pays, for we learn that, to all intents and purposes, the exhibition may be called a German one; German firms have offered to provide sufficient petroleum to drive the whole of the machinery. On the whole exhibitions bring work, but it is not always that those who exhibit reap the benefit. An instance occurred at the Crystal Palace, where a customer saw certain machinery, enquired prices, got a list of firms and obtained tenders, and then a firm who had not exhibited obtained the work. The moral seems to be an argument in favour of syndicates to run electrical departments in exhibitions. Messrs. Birch and Co. have been asked to take up the question by the exhibition authorities. Perhaps it might be worth while a certain number of leading engineers commissioning such a firm to run the general electric department, and so ensure a show of English wares. It is a question, as we have said, of expense against result pure and simple; and organised rightly, perhaps such an arrangement might be profitable.

Electric Heaters.—One of the practical objections to the electric heater as at present constructed is that the wire resistance gets hot. It may seem quibbling to object to this, but the heating and occasional burning out of the wire is a difficulty in some cases, and if it were possible to produce an electrically-heated kettle in which the wires remained quite cool, all the requirements of a perfect heater would be obtained. Heat can be generated by other means than the resistance of the conducting wire: by hysteresis, for instance, and by eddy currents, and with an alternating current it is comparatively easy to obtain this effect. We understand that patents for such an arrangement have been taken out by Sir David Salomons, and an hysteresis kettle is to be placed on the market which may conceivably have a considerable commercial success, as obviating the trouble with heated or burnt conductors. The idea, however, is not, we fear, altogether new, for we remember having seen descriptions and illustrations of heaters on this principle two years ago, as brought out by an American inventor. In our issue for September 18, 1891, we gave a note on this type of heater, invented by Mr. Guttmann. This heater was in the form of a cooking stove, whose iron plates were placed above a magnet receiving an alternating current, and the rapid alternations of polarity on the iron, together with eddy currents, rapidly generate heat, and the plate may be kept sufficiently hot to boil water or cook food. We have not heard further of Mr. Guttmann's heaters, but there seems no reason why adaptations of the principle should not prove successful on alternating circuits.

Alternating-Current Arc Lamp.—A new arc lamp of very ingenious construction has been devised to overcome certain difficulties by Mr. Belfield, the London representative of the Westinghouse Company, and is being made by that company. It is very strong, is applicable particularly to alternating currents, and has no dash-pot. The peculiarity of the arc lamp is the provision of what may be called a mechanical dash-pot controlled by a pendulum. Imagine a short pendulum hanging loosely, and actuated to and fro by an escapement exactly like the pendulum of a clock, but acting simply as a wagging control on the motion of the wheel. The wheel which moves this pendulum is attached to a pinion gearing into a toothed quadrant connected rigidly to a large piece of metal which acts as counterweight. In action this combination resists any sudden change with great energy by setting the vibrator in rapid motion, but for slight movements there is practically no resistance. The mechanical dash-pot so obtained is actuated by the core of a single large solenoid, round which passes the current as usual. A locking mechanism on this combination controls the feed gear of the carbons and the striking of the arc. Its action is as follows: When the current is turned on the carbons are touching; the core pulls up the balance slowly, vibrating the little pendulum spoken of; at a certain point it locks the mechanism and strikes the arc; as the carbons burn and the current weakens a little, the core descends, allows a wag or two of the pendulum, the gear unlocks, and the carbons descend imperceptibly, the flywheel locking again; and so on with the utmost steadiness and regularity. The whole construction is exceedingly strong and mechanical, and can evidently be made at a very moderate cost.

South America.—The amusing and suggestive account of affairs electrical in South America given by Mr. E. H. Tyler in our last issue, will no doubt have a certain fascination for young and adventurous bloods in the profession. A little practical information on the prospects and work in these lands, perhaps, would not come amiss. Broadly speaking, South America from the engineering point of view may be divided into Brazil and Argentina. Brazil offers the best prospect for work, but the climate is certainly much worse, and especially in Rio and Santos—the true homes of yellow fever—unfit for English, though many parts are quite healthy. In Brazil there is plenty of water power, and all the stations, almost without exception, are water-driven. The salaries for superintending and erecting engineers in Brazil run from £30 to £40 a month, and usually include also a house and servants, so that comfort, or even luxury, is assured, though prices are very high. The station, being far away from town to obtain the water power, the engineer must live on the spot, and a house and other buildings are put up when the station is built. Here the engineer leads a life of alternating monotony and excitement. Portuguese is the language spoken, and the men are usually natives. Assistants cannot get much—200dol., or 300 milreis, say, £10 to £15 a month, which is but bare cost of living, and an Englishman would hardly live on this salary. In Argentina the climate is more suitable to English temperaments, but at present there is little opening on account of the recent financial difficulties. Spanish is the language in the Argentine. There is no water power to speak of, steam power being general, wood being used as fuel. The salaries now obtainable in Argentina are much lower than in Brazil, engineers being offered assistants' wages. The race difficulty comes in, for English workmen do not care about working under Argentines. The workmen are mostly Spanish or Indian, and get 45dol. to 70dol. a month. Another difficulty is that the dollar is a variable quantity; its par value is 4s. 2d., but it usually varies between 1s. and 2s., sometimes varying 3d. or 6d. in a day, so that one never knows how much one is worth. In 1887, before the crash, a sovereign was worth 5dol., since then as many as 22dol. have been required to make a pound sterling. The Argentine is not too attractive at present. In Brazil openings sometimes offer tempting scope for money, adventure, and experience; but the greatest care is essential in the towns to guard against fever, and it is not wise for an Englishman to settle there. Returning to Rio after a year up country, one may find half-a-dozen old comrades knocked over by Yellow Jack. Other parts are more healthy, and the whole country is singularly rich in natural resources, and offers scope for enterprise and ingenuity in electrical development.

Lighthouse Illuminants.—The value of a light for the guidance of mariners, says an article in the *Liverpool Journal of Commerce*, should be estimated by its power to pierce or to cast a glare on fog. For the illumination of the towers of lighthouses, there are three systems in vogue—oil, gas, and electricity. Fogs differ in density and in height from the surface of the sea. When they lie low it is possible, under favourable conditions, to see a coast light from aloft. As a rule, however, this view from the mast-head is exceptional, besides which the majority of steamships are too short-masted for a sufficient elevation to be gained, but it does not necessarily follow that the casting of flares up to the clouds should be despised. There is always a probability of fog driving along the sea, and not attaining any particular elevation. Mr. Wigham, at the Society of Arts, in 1882, read a paper on sky reflection, and at the Trinity House trials at the South Foreland in 1885 he established the importance of cloud illumination. If a flash of light upwards is likely to attract the notice of navigators the plan is worthy of adoption. Looking to the importance of warning those in command of large steamships of their proximity to the Irish coast in endeavouring to make for Queenstown, the necessity of having a light of the first order at the Old Head of Kinsale cannot be over-estimated. The Cork Incorporated Chamber of Commerce and Shipping having received authentic reports on the operation of Wigham's "intensity" burner and the "giant" lens, fixed temporarily at Howth Bailey lighthouse, requested, as previously mentioned in these columns, the Commissioners of Irish Lights and the Board of Trade to have the best illuminator fitted at the Old Head of Kinsale, and in connection with it the most powerful fog signal. The Belfast Chamber of Commerce have been furnished with full details, and personal inspection, reports of the Wigham gaslight at Howth Bailey lighthouse, and also the report from Mr. Dunn, pilotage superintendent at Kingstown, backed up the memorial of the Cork Chamber of Commerce and Shipping. Prof. Tyndall agrees with the pilots that the Wigham system would "illuminate fog to a greater extent than any other arrangement in existence." Mr. Arthur A. Rambaut, astronomer royal, of the County Dublin Observatory, who witnessed the Howth Bailey displays, sums up a long letter by remarking that the Wigham apparatus "cannot fail to be of use to sailors in foggy weather, when even so powerful a light as the well-known first-order revolving lens of the Tory Island pattern must fail." Captain Boxer, R.N., retired Inspector of Irish Lighthouses, enters fully into the question, and asserts that he saw the flashes illuminating the haze far up into the sky, and over the horizon for miles. Certificates from the captains of the steamers "Ireland," "Munster," "Connaught," "Violet," "Duke of Argyll," "General Gordon," "Lady Hudson Kinahan," "Countess of Dublin," "Tempest," "Magnet," and "Marley," bear testimony to the efficiency of the improved Wigham light. The unanimity among those whose experience is worth consideration, settles the question of the superiority of the Wigham inventions. The original expense may be in excess of oil installation, but not of electricity. There is a consensus of opinion among masters, pilots, and officers that the electric light is not suitable for the illumination of coasts. Gas-jets can be diminished when not required by the state of the weather, and increased in fogs, haze, snow, or mist. A syren foghorn can be worked by the aid of gas, and as the jets of gas can be flashed, the advantages on its side completely overpower oil or electricity. The Irish Lighthouse Commissioners, concludes the *Journal*, ought therefore to be allowed to carry out their own predilections, and foster the application of gas.

ELECTRIC LIGHTING SCHEMES FOR STRASSBURG.

Some time ago Mr. Oscar von Miller, of Munich, was commissioned by the Mayor of Strassburg to devise schemes for the establishment of a central electric-light station in that town, and to ascertain to what extent the water power of the Rhine could be advantageously utilised in the working of the station. In order to determine the latter question, Mr. Ott, the municipal architect, furnished Mr. Miller with a memorandum, in which was shown the existing demand and expected future requirements for working power, and a scheme for the construction of a branch canal from the Rhine to the Altenheim Hof, as well as for a turbine installation on the Ochsenwörth. The memorandum was accompanied by drawings and estimates. As mentioned in our last issue, Mr. Miller has completed the schemes, the details of which, together with plans and drawings, are embodied in an imposing book. We give below the salient features of the schemes.

The preliminary station comprises the production of current for private lighting and for the operation of motors; and the station, when complete, would also provide electrical energy for the illumination of the streets and for the working of the existing tramway. Investigations showed that for the preliminary installation, plant to the equivalent of 11,500 16-c.p. lamps burning simultaneously must be provided, and for the station when fully equipped it would be necessary to arrange for the simultaneous supply of 34,400 16-c.p. lamps, or their equivalent in lamps of other powers, or in motors for industrial purposes and for the working of the tramway. The power required for the latter would be 400 h.p. With a view to ascertain which system is best suited to local requirements, the following four alternative schemes have been elaborated: (I.) Alternating current with steam power; (II.) continuous current and battery stations with steam power; (III.) alternators, using the water power of the Rhine with steam reserve; (IV.) continuous current with battery stations and alternators with continuous-current transformers, utilising water power with steam reserve.

Steam Alternators.—The most suitable site for the erection of the steam plant, which must be provided for all four projects, is on the Hafenstaden (quay). The site belongs to the town, the feed-water is ready at hand, and a supply of coal can easily be obtained either by ship or rail. The alternators generate at about 3,000 volts, and the current would pass into several feeders connected with transformers in the districts of consumption. The current would then enter a system of distributing mains on the three-wire system.

Steam Dynamos.—Current would be produced at 300 volts, and would reach the five secondary accumulator stations at 220 volts. In order however to obtain the higher pressure required for charging the batteries, additional dynamos, coupled direct to a continuous-current motor, must be installed. These would provide the extra pressure necessary. The batteries would be recharged during the periods of low demand, support the generators when the consumption of current is the greatest, and undertake the whole supply late at night when the plant at the station is shut down. The distribution would be on the three-wire system.

Turbine-Alternators.—According to the proposals of Mr. Ott, the water power of the "small" Rhine would be utilised by the erection of a turbine-house in the neighbourhood of the municipal waterworks on the Ochsenwörth. In order, however, not to delay the construction of the central station, owing to the long time which would be occupied in building the water-power station, but principally to completely safeguard against possible interruptions in the supply of light through the breaking up of the ice or accidents, Mr. Miller proposes for the turbine station a reserve steam power sufficient to eventually take over the maximum work of the turbines. The question then arose as to the locality for the steam reserve plant—whether it should be near the turbine-house, or on the same site as suggested in the first project. Although the adoption of the latter would render the attendance more difficult and more expensive, yet Mr. Miller gives it the preference, because the loss in the mains would be less, the coal could be more readily delivered, the distribution through mains from the distant water-power station would be more expensive, and, before all, because in the case of the preliminary station, the steam plant alone could be laid down without the use of water power, and under these circumstances the installation of steam power only at Ochsenwörth would be very unsatisfactory.

Turbine-Direct-Current Dynamos.—Considering the great loss or excessively dear cables, as in the case of project II. at 300 volts, which would occur, the transmission of electrical energy from the power station to the battery stations would necessitate the use of a much higher pressure. To meet this case, alternating currents are the most suitable. The current, after leaving the switchboard, would pass along an underground cable to the steam generating station on the Hafenstaden. Then the alternating current from the water-power house would be united with that produced by the steam alternators and conveyed to the substations. Here the high-tension current would, by means of alternating continuous-current transformers, be converted and reduced for charging the batteries and for supplying direct to the distributing mains on the three-wire system.

With these general remarks, we now give the accompanying tables, A, B, C, and D, which are summaries of more detailed tables concerning the four alternate schemes.

The cost of installation for the preliminary plant and complete station, and for the whole of the four projects, is given in Table B.

The cost of acquiring the ground and construction of works is estimated from the figures furnished by Mr. Ott, whilst the plant is calculated according to the prices of prominent manufacturers. The working expenses are based upon exhaustive calculations in which the losses in each single part of the installation have been minutely considered. The figures are given in Table C. These working expenses render it possible to fix an average rate of ·42d. per 16-c.p. lamp per hour in the case of the preliminary plant, and of ·36d. for the complete station; a charge of 1·44d. per arc lamp of 1,000 nominal candle-power per hour; electric power at the rate of 2·16d. per horse-power hour and 1·62d. per horse-power hour in the two cases; and power for the tramway at ·78d. per horse-power hour. Taking into consideration these favourable charges, the estimated annual surpluses work out as given in Table D.

It will be seen from the table that the most satisfactory financial results are obtained both in the case of the preliminary plant and complete station, and both by the exclusive use of steam power and the utilisation of water power in conjunction with the alternating-current transformer system. Bearing these results in mind, and considering the fact that both alternating and continuous currents are of equal value for light and power, Mr. Miller recommends the erection and equipment of the electricity works on the alternating-current system. The preliminary plant could be laid down for steam power, whilst the water power of the Rhine could be used with advantage on enlarging the station as soon as 1,000 h.p. could be delivered to works, etc. If the water power were fully utilised, there would still be an output at the central station of 2,500 h.p. available for other purposes, and which would yield a further surplus annually. As a commencement, Mr. Miller suggests that applications should be made to the inhabitants for the supply of electrical energy on the basis of the tariff previously mentioned, and that tenders should be invited from the leading firms for the construction and equipment of the preliminary station on the alternating-current system with the use of steam power.

It may be interesting to conclude this abstract by giving further particulars concerning the initial installation recommended by Mr. Miller. The 11,500 lamps simultaneously alight correspond with 18,000 installed, and for the supply of these three alternators of from 400 h.p. to 500 h.p. are proposed, which would leave practically duplicate power in reserve. The mains, which are calculated for 20,000 lamps, will be laid underground. As far as the boilers are concerned, Mr. Miller recommends the adoption of those of the water-tube type, as requiring less fuel and raising steam more quickly than Cornish boilers. There would be four boilers working at 135lb. pressure; and

TABLE A.—STATEMENT OF POWER PLANT.

—	Preliminary plant.				Complete station.			
	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.
	Steam power.		Water power.		Steam power.		Water power.	
Maximum output of steam-engine plant in effective horse-power	1,000	400	1,000	450	3,000	1,600	3,000	1,800
Maximum output of turbine plant in effective horse-power	—	—	600	400	—	—	1,200	1,200
Yearly output of steam-engines in indicated horse-power hours	2,481,000	2,100,700	85,600	—	8,820,000	9,180,000	1,045,000	437,000
Yearly output of turbines in effective horse-power hours.	—	—	2,030,000	2,330,000	—	—	7,560,000	9,320,000

TABLE B.—COST OF INSTALLATION.

—	Preliminary plant.				Complete station.			
	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.
	Steam power.		Water power.		Steam power.		Water power.	
	£	£	£	£	£	£	£	£
Acquisition of ground, and building and street works	13,665	20,121	84,685	93,411	28,840	34,605	102,700	111,182
Generating plant, transformers, accumulators, and cable network	39,462	55.895	47,780	60,185	95,395	133,370	113,500	146,252
Various	6,822	9,584	9,135	11,104	14,665	19,225	17,300	21,266
Total	£59,949	£85,600	£141,600	£164,700	£138,900	£187,200	£233,500	£278,700

TABLE C.—ANNUAL WORKING EXPENDITURE.

—	Preliminary plant.				Complete station.			
	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.
	Steam power.		Water power.		Steam power.		Water power.	
	£	£	£	£	£	£	£	£
Interest	2,398	3,424	5,664	6,588	5,556	7,488	9,340	11,148
Maintenance and depreciation	3,486	4,802	5,452	6,718	8,203	10,920	10,816	14,216
Management, working *personnel*, and material......	5,550	5,462	2,227	2,451	15,355	17,508	5,295	4,688
Contingencies and reserve fund..............	1,216	1,412	1,232	1,443	3,146	3,634	2,523	2,823
Total working expenses ...	£12,650	£15,100	£14,575	£17,200	£32,260	£39,550	£27,974	£32,875

TABLE D.—YEARLY SURPLUS.

—	Preliminary plant.				Complete station.			
	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.	I. Alternating current.	II. Direct current.	III. Alternating current.	IV. Direct current.
	Steam power.		Water power.		Steam power.		Water power.	
	£	£	£	£	£	£	£	£
Annual receipts	16,748	16,748	16,748	16,748	42,630	42,630	42,630	42,630
Annual expenditure..	12,650	15,100	14,575	17,200	32,260	39,550	27,975	32,875
Annual surplus.........	£4,098	£1,648	£2,173	– 452	£10,370	£3,080	£14,655	£9,755

three compound condensing steam-engines giving at 115 revolutions from 400 h.p. to 500 h.p., and coupled direct to alternators with their exciting dynamos. The cables would be of the iron-armoured concentric lead type.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 23.

Mr. W. H. Preece, F.R.S., President, in the chair.

ON TESTING AND WORKING ALTERNATORS.

BY W. M. MORDEY, MEMBER OF COUNCIL.

(Concluded from page 207.)

Another way, arising naturally out of Fig. 3, is to circulate the power given by the portion G back to the circuit of A to M instead of wasting it on the resistance, R. This may be done by putting one winding of a transformer of suitable size in place of the resistance, R, and a second winding of the transformer in the circuit between A and M. In order that this should succeed, it is necessary that the transformer should be capable of allowing a sufficient current to pass through one winding alone to run the machine as a motor lightly loaded. Then the portion M will be traversed by a current larger than that produced by G, otherwise the machine would not run as a motor.

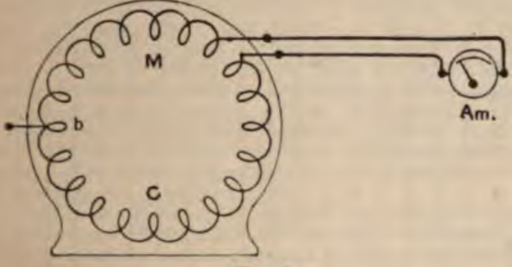


Fig. 1.

Another way, which has the advantage of being a complete electrical method, is shown by Fig. 4.

The armature, A′, of the alternator to be tested is divided into, say, three portions—*a*, *b*, and *c*—which are so joined up that the portions *a* and *b* neutralise one another so far as E.M.F. and power are concerned. Then the machine is run up to synchronism with the generator, A, which is made to supply current to A′, and the belt is thrown off. It will be evident that A′ runs as a motor purely by virtue of the power of portion *c*. The portions *a* and *b* do nothing. If the field of A′ is suitably excited and the portion *c* is correctly proportioned, the full working current may be forced through the whole armature, and all the internal conditions of full load will be observed, with the exception that the torque will not be in the same sense all round the armature—a matter that does not interfere with the accuracy and value of the test. A single wattmeter reading taken at the terminals will then give the whole of the power expended in the machine, including mechanical and electrical friction and eddies, as well as excitation, if the exciter is directly driven.

Other ways of driving the alternator electrically, and of testing it under the conditions of full load, will readily suggest themselves. For instance, a portion of the armature may be separated from the remainder and supplied with power from an external synchronous source sufficient to run the whole machine, and the portions not so used may be used, as in Fig. 1 or Fig. 2, to circulate power within the machine. In such an arrangement, however, the different portions of the armature are not equally loaded. Running at full current and small power may also be done by using simple choking coils for the external circuit, but this introduces disturbing influences which make it of very little use.

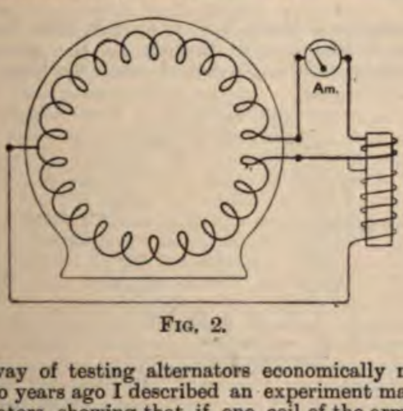


Fig. 2.

Another way of testing alternators economically may be mentioned. Two years ago I described an experiment made with one of my alternators, showing that if one coil of the armature is left out of circuit, as shown in Fig. 5, the E.M.F. of that coil remains constant whatever load may be imposed on other portions of the armature, so long as the speed and excitation remain constant. I found also that the true load characteristic for the whole armature might be taken by loading one coil only. This being the case, it follows that an alternator may be fully tested by an engine or motor capable of running only a very small portion of its load. Such a test, although giving all needed electrical information, does not cover the practical considerations that render advisable the long-continued running under the conditions of full load. But it may sometimes prove to be useful. It follows from this that if a portion of the armature be used as a motor, another portion may be loaded as a generator and the full-load characteristic of the machine obtained, while another portion may be run on a voltmeter only and the open-circuit characteristic ascertained.

I will not occupy further time by alluding to other modifications of this kind. Those I have described suffice to show how useful results may be obtained.

Power Factor of Alternating-Current Motors.

The "power factor," or "plant efficiency," of alternate-current motors, whether synchronous or not, is a subject of great importance, on account of its bearing on the economics of power transmission by alternate currents. Although at the moment the power factor of motors is not as pressing a matter as the power factor of transformers (which has received Dr. Fleming's recent attention), it is desirable to find whether for alternate-current motors we have to use cables and machinery capable of carrying a large idle current, or whether we can treat power-transmission projects, so far as these matters are concerned, in the simple manner that is possible with alternate-current transmission with good closed magnetic circuit transformers. I am able to say that, so far as my own observations go, working with one class of alternators, the power factor of these machines when used as motors under fair loads is very high, if they are used under conditions that are easily obtained.

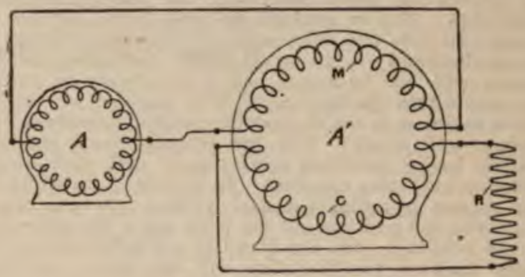


Fig. 3.

Fig. 6 illustrates the way in which the power factor varies with the excitation. The two V-shaped curves show the current that was taken respectively by an "A 7" 25-kilowatt alternator, and by an "A 10" 50-kilowatt alternator, running as motors, without load, when the excitation was varied. They were driven by another alternator, and a P.D. of 2,000 volts was maintained across the terminals. Speed constant at 100 ∼. It will be observed that in each case there is an excitation that reduces the armature current to a minimum, and therefore gives a maximum load factor and maximum efficiency. If the excitation is varied on either side of that value, the armature current rapidly increases. In order to find whether the same kind of effect takes place when the motor is loaded, one of the motors was made to drive another alternator the load on which was varied. It was found, as was to be expected, that with various loads, and, of course, at constant speed, there was for each load an excitation that corresponded with a minimum armature current; that the armature current rose on varying the excitation either up or down; and that the excitation that gave the lowest armature current (or the highest efficiency and highest power factor) was approximately the same for all loads, with the same impressed P.D. This is what one would expect. With a weak field, a large armature current is required to give the necessary torque; while with a strong field the E.M.F. of the motor is higher than that of the generator; the driving current, therefore, is large for a given torque, as it cannot get in advantageously.

It will be remembered that Dr. Hopkinson predicted years ago that an alternator would run as a motor under the condition of the motor having a higher E.M.F. than the generator. From these curves we see that the power factor may vary enormously, but there is no difficulty in making it a minimum, and the efficiency a maximum, by always working at the excitation that gives the lowest reading of current. It will be seen from the table of results given above that the power factor is high. It appears to fall away at no load to a much lower value, as will be seen from an examination of the two curves. This, however, is of no practical moment, as the machines do not take much to drive them under light load conditions; and although I have not made determinations at intermediate points, it appears that, as was shown by Dr. Fleming to be the case with closed-circuit transformers, the load factor approached unity as soon as the load was put on. It is satisfactory to find that in this respect these two classes of alternate-current apparatus have similar qualities.

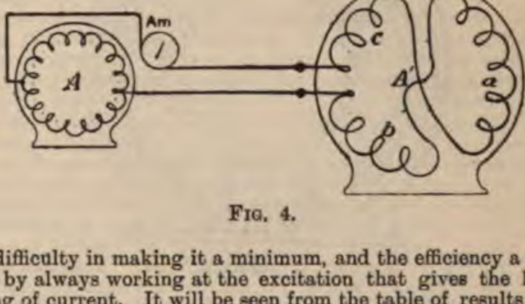


Fig. 4.

The present opportunity may be taken to allude to a device which I have used for some time in connection with the workin

TEST OF "A 10" ALTERNATOR.

Motor portion.					Generator portion.			Excitation.				
C.	V.	Wattmeter, W.	C × V.	Power factor $\frac{W}{C \times V}$.	C′.	V′.	C′ × V′.	Watts, *w*.	W + *w*.	Dynamotor efficiency, $\frac{C' \times V'}{W + w}$.	Losses, W + *w* − (C′ × V′).	Commercial efficiency, $\frac{2C' \times V'}{W + (C' \times V') + w}$.
8·023	2,000	15,344	16,064	0·95	6 9	1,960	13,584	420	15,764	0·868	2,180	0·9257
9·278	2,000	17,628	18,556	0·95	8·1	1,950	15,855	427	18,055	0·878	2,200	0·935
10·5	2,000	19,950	21,000	0·95	9·3	1,940	18,102	427	20,380	0·89	2,278	0·941
10·22	2,000	19,418	20,440	0·95	8·6	2,040	17,604	465·9	19,884	0·885	2,280	0·938

of alternators, and which we apply to all the larger machines. In alternator armatures there are advantages in having the coils arranged in two or more parallel portions, instead of all in series. The insulation of the terminal portions of the winding is easier, and, except in small machines, the conductors are more manageable. But in practice we have found that the parallel arrangement has one drawback. Unless the coils are equally and simultaneously acted on all round, the voltage of the two portions will not be equal, and a circulation of current will take place within the armature. The machine will, in fact, act to some extent as in the dynamotor method described, and a loss of power will result. This has probably been overlooked in machines having revolving armatures, as with such armatures it is not easy to observe the effect. It is difficult to avoid this circular current by ordinary means. If the pole-faces are exactly alike in size and position, and the polar gap is the same all round, and the armature coils are identical in winding and in relative angular position, the inequality will not exist. But these are conditions that can only be certainly obtained at a considerable expense. With cast magnets the poles vary a little. The armature coils are adjusted radially, and it would be troublesome and expensive to place them so as to comply with the conditions mentioned. By a simple application of a known property of transformers this difficulty is avoided. This is shown in Fig. 7. A pair of similar coils is arranged in the manner of a transformer, one coil being placed in each half of the armature circuit. The connections are such that with equal currents from the two portions of the armature there is no magnetism induced, the two windings neutralising one another. But any tendency of one portion of the armature to give a larger current than the other portion is resisted by the "equaliser" (as I term this apparatus), which then acts as a transformer opposing an E.M.F. in the circuit which has an excess, and adding a corresponding E.M.F. to the circuit of lower voltage. Thus the two portions of the armature contribute equally to the external circuit, while the circular current is prevented, whether on open circuit or under load. The equaliser is quite a small affair. As an example of its efficacy, I may mention that in one case the two sides of a 250-kilowatt 2,000-volt alternator were made so unequal that a current of 16 amperes circulated. The addition of a small "equaliser" reduced this circular current to half an ampere. I do not know whether this inequality has been noticed by others, but it is well known that it may exist in direct-current dynamos when different parts of the armature are acted upon unequally, and it has been cited as an objection to the parallel winding and connection of armatures in such machines with multi-polar fields. Whatever force there may be in this objection, it will be granted that it is not as easily met as in alternators. Indeed, it may be said of alternate-current apparatus generally, that, although difficulties are met with, and often of an unexpected kind, their very nature provides us with new and simple means of avoiding or reducing them.

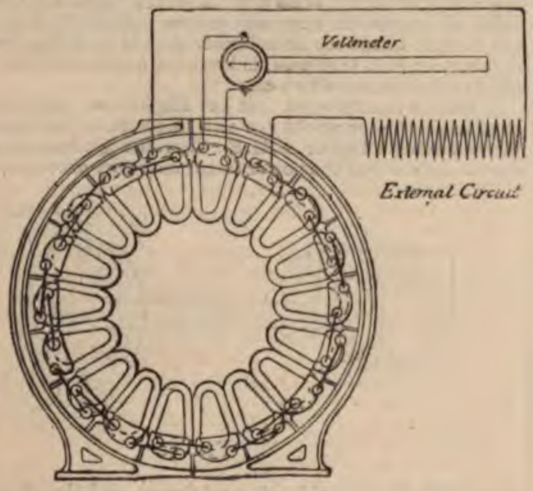


FIG. 5.

In iron-cored armatures, whether of alternators or dynamos, the iron core may to some extent tend to counteract inequalities of this sort.

PARALLEL WORKING OF ALTERNATORS.

This subject has received a great deal of attention during the last few years. I do not desire to add anything to the literature dealing with its theoretical aspects, but, as it may be of interest to some members of this Institution, I take the opportunity of giving a description of the principles on which my colleagues and I act in dealing practically with parallel working. Some years ago Mr. Raworth and I recognised that this was quite as much a question of prime motors as of electrical apparatus, and we then settled on the main points of the arrangements for parallel working, which have been acted on ever since, practically without change. 1. Each alternator is driven by a separate engine. 2. All the engines are in parallel on the steam-pipe, and are supplied with steam at the same pressure. 3. All the alternator fields are magnetised in parallel, and are supplied with current at the same pressure. 4. All the alternator armatures are in parallel, and supply current into the mains at the same pressure. 5. Each alternator gives its proper proportion of load by regulation of the amount of steam admitted to its engine. 6. The regulation of potential difference is by the control of the common exciter. Thus it will be seen that the individual regulation of current (that is, of load) of each alternator is entirely by control of the steam supplied to its engine.

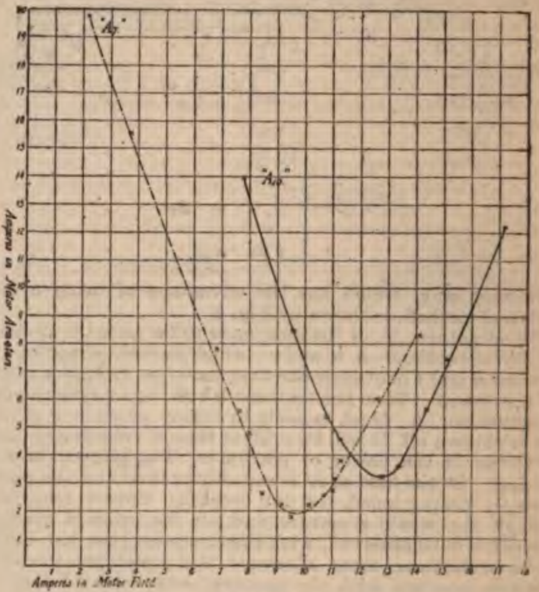


FIG. 6.

The regulation of the E.M.F. as a whole is by the control of the excitation simultaneously affecting all the alternators. Each engine must be capable of control when working, either by the stop-valve or by having a governor capable of adjustment when running.

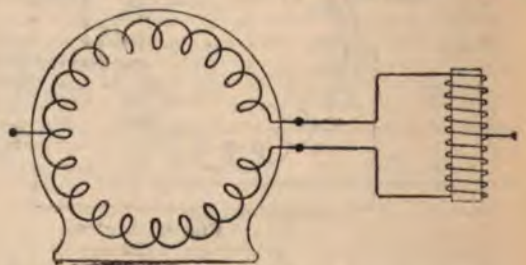


FIG. 7.

In working alternators in parallel, the precautions that should be observed will be best understood by a consideration of the following: Consider the case of two alternators. Assume that one alternator, A, is running and doing work driven by its engine, E, and that it is required to start the second alternator, A_1, with its engine, E_1. Start the engine E_1 and excite the alternator A_1. If the fields of the alternators are excited in parallel from the same exciting source—as is preferred, and as we arrange whenever possible—there is no necessity for any adjustment of the individual excitation (except for differences of temperature). It is merely necessary to connect the field to the exciter without resistance. It will then receive the proper field current. Let the double-pole main switch of A_1 be open. The synchroniser is then to be switched on, and the speed of the engine E_1 adjusted till the synchroniser lamp is steady, showing that the alternators, A and A_1, are running at the same speed. It will not be found difficult to so adjust the engine E_1 that the synchroniser lamp shall remain steady for several seconds at a time For greater accuracy a voltmeter may be used instead of or in addition to the synchroniser lamp. When the synchroniser lamp (or voltmeter) is at its highest, the double-pole main switch of A_1 should be closed, so connecting the alternators in parallel. It will be perceived that at this time the engine E_1 is only supplied with steam sufficient to drive the alternator A_1 (without load) at the required speed. The alternators, when put in parallel, will therefore merely keep in step, A_1 doing no work on the external circuit and receiving no power from that circuit. This will be shown by its ammeter, which will show that no current, or only a very small current, passes between the machines. As the supply of steam is increased, the ammeter of A_1 will show an increased reading, while that of A will show a decreased reading, until (in the case of alternators of the same size) the two instruments show that the load is equally divided between the machines. When this condition is attained no further regulation of engines is required, any increase or decrease of load dividing equally between them. The control of E.M.F. is effected by regulating the exciter, and not by means of resistances in the field circuits of the alternators. As the fields are all wound to excite from the same mains, there is no need for an individual regulation of the fields, except, perhaps, a slight adjustment to compensate for difference of temperature between machines that are being started cold to work with others that have become warm by long running. The field ammeter should be observed in order to give each machine the same excitation.

To stop one alternator when two or more are running, the load should not be switched off suddenly, but steam should be gradually reduced by the governor or stop-valve of the engine until the alternator is doing no work, as shown by its ammeter. Then the switch between the alternator and mains should be opened and the engine stopped. If the steam is gradually reduced in this way, the load will be transferred to the remaining engines and alternators before the machine is switched off, and no racing of the engine can occur. Steam should be turned off till the ammeter needle goes back to zero, showing that the alternator is not doing any work. If steam is continued to be turned off beyond this point, the alternator will then take current (to drive it as a motor and to enable it to drive its engine), and the ammeter needle will, after going back to zero, show a deflection representing this received current. It may perhaps be pointed out that artificial loads need not be used in putting alternators in parallel. This is sometimes done, but it can only be necessary where the characteristics of the machines show great variations between no load and full load.

In conclusion, I have to thank the Brush Company for the preparation of the diagrams; and my hearty acknowledgments are due to Mr. Woof and Mr. Watson, two of the company's heads of works departments, and to Messrs. Stobart, Hansard, and Foyster, students and assistants, for much careful and willing assistance in carrying out trials by these methods.

THE "SERIES METHOD" AS APPLIED TO THE TECHNICAL PROFESSIONS.*

BY HOWARD SWAN.

The subject of my lecture is the application of a newly introduced method, invented by M. Gouin, of Paris, of teaching languages (with which I have been connected as translator), and the relation of this method to the technical professions. The practical result of this method has been singularly successful, and as the principles which underlie it are of equal interest when applied to other subjects, I have thought it worth while to bring before your notice some account of these principles. The problem of learning foreign languages itself is of great importance in the technical professions, and this point was emphasised by Prof. Ayrton in his recent presidential address. As assistant-editor of one of the technical journals, it has been my duty to deal with many foreign journals, and some of these are on the table for your inspection. Among these in the French language are *L'Electricien*, *L'Industrie Electrique*, *Le Bulletin Internationale de l'Electricité*, *Electricité*, *La Lumière Electrique*, *Revue Industrielle*; Belgian: *Bulletin de la Société Belge d'Electriciens*; Swiss: *Le Journal Telegraphique*; German: *Elektrotechnische Zeitschrift*, *Dingler's Polytechnische Journal*, *Elektrotechnische Anzeiger*; Austrian: *Zeitschrift fur Electrotechnik*; Italian: *Elettricità*; Spanish: *El Telegrafo Espanol*, *Electricidad*; besides Russian and Hungarian journals. I have also "Bibliotheca Polytechnica" (directory of technical literature), F. V. Szczepanski (Sampson Low), and "Dictionnaire d'Electricité et de Magnetisme, par E. Jacquez," in French, English, and German (C. Klincksieck, 11, Rue de Lille, Paris).

For the technical student the knowledge of one or two modern languages besides his own is extremely desirable, if not absolutely necessary. A great deal of the scientific progress of the world is published first in French and German, and the result of research exists in works which remain practically useless for the greater part of English engineers, from the want of a knowledge of these languages.

For the practical engineer the languages, after French and German, which are most needed are Spanish and Portuguese, for these are spoken over large tracts of America and Africa as well as in their native lands. The knowledge of a language often makes a considerable addition to the usefulness of an engineer, and therefore to his salary, and cases are not uncommon where the possession of a language has doubled a young engineer's income. Then how is it, where utility is so well admitted, that success so seldom attends the efforts of the student to acquire languages at college?

The science of language-teaching is much in the same position to-day as that of mechanical engineering before the discovery by Dr. Joule of the mechanical equivalent of heat. Occasional efficient results are obtained, but no comparison-point existing—no mechanical equivalent of learning, so to speak—neither students nor teacher know exactly the ideal efficiency of the human mind in this respect and have no incentive to attain it. It was not until the inventor of the method which is the subject of this paper had organised the material hitherto lying chaotically before him, and both acted as the Darwin and the Joule of pedagogic science, that any exact comparison has been possible.

In truth, the professorial science has been widely astray, and much laborious work has been carried out in entirely wrong directions. This error does not exist alone for languages but for nearly all subjects, though the teaching of the physical sciences suffer least in this respect. The means hitherto taken for learning a language has been to associate a written word in one language with the written word in another. Now in reality all words at first are very much the same to the eye—black marks on white paper. At 6ft. distance the best eye cannot well distinguish the words "horse" from "house"; while at 100 yards every person not blind can well distinguish the realities these words stand for. In learning a new language, the association of printed word to printed word has been taken; but instead of this, there should have been taken the association of a mental picture to a sound.

What is meant, we may ask, by understanding a language? When any simple statement is spoken or read aloud in the native tongue the recital is at once understood by a second person. Take, for instance, the following: "The engine-driver wishes to start his engine; the steam pressure is low; so the stoker fires up and the steam pressure gradually rises." Of course everyone understands this. But why? Because you understand the words, you may answer. But what is meant by "understanding words"? By this is really meant, that on hearing the words, your brain transformed the sounds of which they consist into mental pictures. On hearing the word "stoker," this sound is transformed into a mental picture of a workman, rather dirty, holding a shovelful of coals; the words "fires up" is transformed into the mental picture of his action of shoveling the coals into the furnace of a boiler; you can see the swing of his arms, you can see the burst of flame and smoke as the coals fall on the fire-grate, you can hear mentally the grating of the shovel as he takes his next shovelful, and you can feel the warmth from the furnace—all this springs unbidden to your mind at the words "the stoker fires up." Then the words "the steam rises." Not so much do you see the letters *s*, *t*, *e*, *a*, *m* or *r*, *i*, *s*, *e*, *s*; but the image of a steam-gauge appears before your eyes and you see the index creeping round to a higher figure—"the steam rises. You can if you like imagine the safety-valve beginning to blow off, and all this springs as a photograph to the mind when the words are uttered in your hearing. And it is certainly more living than a picture, for the things and beings are coloured, in relief and moving in your mental conception. Every word is thus visualised, consciously or unconsciously. The word "gradually," for instance; you see the index going up, not suddenly, but degree by degree. Moreover, many details are seen, or may be seen, even when unexpressed—*e.g.*, the shovel, steam-gauge, and so forth, so accurate is the mental image when examined and analysed.

What happens when the sounds of an unknown tongue are uttered before you? The answer is simple: you hear the sounds, but the brain does not transform the sounds into mental pictures; result, you do not understand.

The first question to ask, then, is this: How to obtain the same transformation of sound into mental pictures with the foreign language.

But as yet we have only investigated what goes on in the mind of the hearer. What goes on in the mind of the speaker is a similar process, but in reverse order. To give the recital, the speaker first forms the complete picture in his mind, then separating out the various phases of the action, he names them by using the proper expressions. These expressions he does not have to seek for long. They spring forth from the mental picture intuitively as soon as the picture is fully formed. To show how this occurs, let me construct a picture in your minds without naming the object. Imagine a tall farmer's implement of the shape of the letter F, with two handles for grasping, bearing at one end a long, sharp, curved blade; it is used for mowing grass. No sooner is the image formed than you "hear" the word in your ears—"scythe." Thus far with an object; now for an action. Imagine the farmer holding the scythe, he takes out a hone, and right and left he rubs the scythe. What is he doing? You hear the words "sharpening the scythe." We see from this that in speaking we speak upon mental pictures of which we know the proper titles.

The second question, therefore, is: How to obtain the same result, that the mental picture shall give rise to the sound of the name in a foreign tongue?

These two questions are, in reality, one, and the same answer does for both. The name of an object is usually traditional, bearing no obvious relation to the roots of the language. In the mother tongue it has been associated from childhood up, first with the object and then with the mental picture of this, until both nam and object become one—they are indissolubly associ

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* Lecture delivered before the City Guilds Institute Old Students' Association, 22nd February, 1893.

This "association" in the mind is the true and only connection, and in learning a new language the sooner the association is brought about the sooner will the language be learnt. This association should be a direct association of foreign word to mental picture, and not a roundabout association to the picture by way of the English—the two sides of a triangle are always longer than one. As long as a student is conscious of letters and words to the exclusion of the inner meaning—viz., the mental picture—he is on the wrong path, and has left behind his "gift for languages."

Careful experiment has shown that six or seven repetitions aloud, slowly and distinctly, by one who knows the language, when the mental image is vividly called up in the mind of the learner, are sufficient to create this association ; 10 or 12 repetitions rendered it practically ineffaceable. After a little practice the teacher can associate 25 complete idiomatic sentences in a quarter of an hour—that is, 100 an hour—which are afterwards written out. This, at an hour a day, for six months or so, will give complete command over 100,000 idomatic sentences, which is already a good stock, and as many as are ordinarily required for the basic knowledge of a language. To ensure that the picture is present in the mind during every repetition, the details must be brought vividly up, and it is this picture the learner must attend to, not the word—the word will enter the ear and become associated therewith. For instance, in learning the word "brushes" (of a dynamo), the hearer (it is essential that the *sound* be used, and not a printed word) is invited to look in imagination at the brushes—"balais, les balais" (pronounced "lé băl-lé," é as in "let"); he must see the brushes pressing on the commutator, copper brushes—"balais, les balais" ; he must see in his mind the gauze or what not of which they are made—"balais, les balais" ; he must look for the sparking (there should be none !)—"balais, les balais" ; and he can see the cables are connected to the "balais, les balais." The association is now fully formed, and every detail that occurs to a French electrician's mind is now perceived by the student when the words "les balais" are spoken before him. The same association can be formed for a verb—for instance, "sharpens" if the word "aiguise" (pronounced "ai-güeez") be repeated several times, while mentally watching the mower in the hayfield making the various actions of sharpening his scythe—now at the tip—"aiguise" ; now further down—"aiguise" ; and now near the handle—"aiguise." Every objective verb can thus be visualised.

So much granted—and a little experiment will demonstrate the enormous power of the ear in associating the right sound with the picture—it remains to be seen how to apply this practically, and more particularly to technical expressions. One might take all the words and actions in alphabetical order, as now given in dictionaries, and associate them as mentioned with the mental conceptions. But this order of proceeding would be arbitrary and illogical. To obtain the true effect of life, and to have the expressions living, we must take a series or sequence of actions, naturally springing one out of the other, in the order of "succession in time" or of "cause and effect." This utilisation of the natural order in a series of actions is what gives the title of the "Series Method," and this insistance on the necessity for logical order has consequences in other fields than the teaching of languages. For, if we grasp it thoroughly, all knowledge that we possess in our brains must consist essentially of mental pictures, classed more or less logically. When I speak of "five million lines of force passing through the field of a Kapp alternator," every electrical engineer sees an image in his mind. Not so an untechnical person, for whom the words convey no picture. Now, if knowledge consists in reality of mental images, then the "knowledge" of electrical science consists in the possession of a large number of such images, grouped and classified and digested. How many? Does anyone know? Has anyone counted? And what amount of time is necessary for the student to be put into possession of this total of classified mental photographs to be able to understand electricity? No exact experiments have been made, but they might be made; and it is probable that Sir William Thomson's dictum, that a mechanical engineer could learn the whole science of electricity in three months, may be absolutely true so far as regards practical knowledge, if only the desired mental pictures were first carefully arranged, and then properly associated with the technical expressions. Moreover, the cultivation of the power of mental visualisation (the very existence of which is sometimes actually denied) so achieved could not but have the greatest effect in stimulating the power of observation, the power of thinking logically, the power of designing, and of realising actualities, which is, indeed, the genius of the engineer, the artist, or the architect.

Returning to the problem of the application of these principles to technical work, let us suppose it is desired to learn the exact idiomatic phrases relating to the working of a dynamo and the production of the electric light, taking only the principal technical expressions. We will take the series of actions as follows, placing each action, for clearness, on a line by itself:

The Dynamo Produces Electric Light.

I. The engine-driver starts the engine,
the engine works,
the flywheel turns round,
moves the belt,
the belt transmits the mechanical force to the pulley,
and drives the dynamo.

II. The axle of the dynamo turns in its bearings,
the Gramme ring armature rotates between the poles of the field magnets,
the armature coils cross the magnetic field,
and cut the lines of force ;
alternate currents are generated in the armature.

III. These alternate currents pass to the commutator,
the commutator commutes the alternate currents into currents of the same direction,
the brushes collect these currents,
and a continuous current passes round the field magnets.
This current energises the electromagnet,
the current increases in the dynamo,
and the E.M.F. reaches the normal voltage.

IV. The electrical engineer turns the switch,
and so closes the exterior circuit ;
the current flows along the conducting wire,
passes into the arc lamp,
the lamp lights up,
the arc lamp mechanism regulates the movement of the carbons—positive and negative,
the projector throws out a beam of electric light,
and the lighthouse lights the mariner during the night.

The corresponding French for this same series of actions is as follows:

La Dynamo produit de la Lumiere Electrique.

I. Le mécanicien met la machine à vapeur en marche,
la machine (le moteur) fonctionne,
le volant tourne,
met la courroie de transmission en mouvement,
la courroie transmet la force mécanique à la poulie,
et actionne la dynamo.

II. L'axe de la dynamo tourne dans les paliers,
l'anneau Gramme tourne entre les pôles des electro-aimants ;
les bobines de l'induit traversent le champ magnétique,
et coupent les lignes de force ;
des courants alternatifs sont engendrés dans l'armature.

III. Ces courants alternatifs passent par le collecteur,
le collecteur transforme les courants alternatifs en courants de même sens,
les balais recueillent ces courants,
et un courant continu passe dans l'inducteur.
Ce courant excite l'électro-aimant,
le courant augmente dans la dynamo,
et la force electromotive atteint la tension normale.

IV. L'ingénieur-électricien touche l'interrupteur (le commutateur)
et ainsi ferme le circuit extérieur ;
le courant passe dans le fil conducteur,
passe dans la lampe à arc,
la lampe s'allume,
le régulateur règle le mouvement des charbons—positif et négatif,
le reflecteur projette au loin la lumière électrique,
et le phare éclaire le navigateur pendant la nuit.

To this, in teaching, may be added some phrases expressive of mental attitudes, instead of objective realities ; phrases extremely useful in directing the work of a station, such as :

"It is time to start. Now then, make haste! Take care; don't make a mistake! That's all right."

In French: "Il est temps de se mettre en train. Allons! dépêchez-vous. Attention! Ne vous trompez pas. Ca marche bien!"

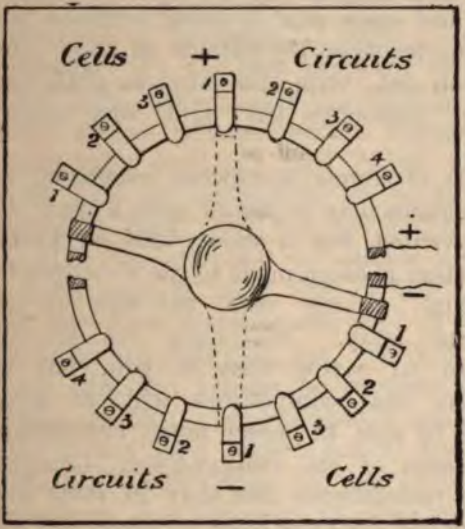
In teaching the technical phrases the mental image of the whole scene would be first called up—driver, engine-room, and dynamo the various actions of the first part would then be separated out, and the foreign *verbs* first connected to the actions in the manner already explained ; then the whole phrases would be gradually built up, defining the details of the action, as was done for "les balais." This would be done several times through, until thoroughly known. On asking the student to repeat this, the interlocutory phrases above mentioned can be utilised in real action, and with living accent: "Il est temps de se mettre en train. Allons! dépêchez-vous!" etc. The same for the second, third, and fourth divisions, after which the whole, being well known, can be first read out and then written, the student being urged to see through the paper into the theatre of the imagination, so as to realise again the inner meaning. All this could be accomplished within half an hour, and these 26 technical expressions would be then fully learnt—and correctly learnt. They are no longer phrases in an unknown tongue, nor are they merely translated ; they have been lived over again on imagined actualities ; and when the time comes to use them they will be at the service of the student. An hour a day for a few months would put him into complete possession of all that part of the language that he most requires. Not only so, but the training in logical and clear arrangement of mental ideas will be of immense service: the exact routine, for instance, of firing, starting an engine, and running a dynamo, will have been taught almost as well as in actual practice, and the power of mental visualisation so trained will also be of the greatest service in cultivating that faculty, which is of the utmost use to every engineer engaged in designing, laying out, and erecting all kinds of machinery.

I have attempted briefly, and in as interesting a manner as possible, to indicate the means which might be adopted in schools and colleges for the rapid acquirement of the linguistic knowledge necessary for the technical professions. I am pleased to see that several institutions, such as the Polytechnic, the Birkbeck, and others, are already taking up this idea to some extent under the guidance of Senor Eduardo Tolra, of 70, Cornhill, who is known amongst electrical engineers as a technical linguistic expert. It is to be hoped that when the principles which underlie the Series method become appreciated and tested, that its adoption may save much of the useless drudgery that is now so often regretted by students in their later life.

Let me point out as a last remark that a full set of such "series" would constitute a new kind of dictionary, in which the words would be classified naturally and logically, instead of being assorted in mere alphabetical order; and the whole expression, instead of isolated words, will be found in such a catalogue of actions if properly constructed, at the proper place, and in its true signification.

VOLTMETER SWITCH.

The accompanying sketch shows a very simple, easily-constructed, and exceedingly-convenient double-poled voltmeter switch for use in central stations, designed by Mr. Malcolm Sutherland. It consists of a split brass ring, a number of brass clips or contact-pieces, and an arm of vulcanite, having at each end brass contact-pieces, and a handle in the centre for turning it. The number of clips depends on the number of points at which it is required to measure the potential. The illustration shows one which was made to read the potential of three sets of accumulators and four circuits. The wires from the voltmeter are connected, one to each half of the ring, and the wires from the cells and circuits are brought to the clips ranged round the outside of the ring. The clips are clear of the ring, and so long as the arm is in the position shown in the sketch, the voltmeter is entirely disconnected from the cells and circuits. When it is necessary to take a reading, all that has to be done is to turn the handle so as to bring the brass contact-pieces between the clips and the ring. Thus the dotted line shows the arm in position for taking a reading from circuit No. 1.



Voltmeter Switch

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICAL REVIEW AND *SCIENCE SIFTINGS* DEFENCE FUND.

SIR,—In view of the litigation now pending between the respective proprietors of the two newspapers, the *Electrical Review* and *Science Siftings*, on the one hand, and C. B. Harness and the Medical Battery Company on the other, arising out of criticisms in these papers on the proceedings of Mr. Harness and the company before mentioned, there is a wide-spread feeling in the medical and electrical professions that the proprietors of these papers should receive ample pecuniary assistance in their public-spirited endeavour to have the issues raised fully investigated in the Law Courts, which will necessarily involve a considerable expenditure.

A committee, consisting of the following gentlemen, has been formed for the purpose of raising a fund for the before-mentioned purposes: Mr. Latimer Clark, F.R.S., Prof. G. Carey-Foster, F.R.S., Dr. John Hopkinson, F.R.S., Prof. G. B. Howes, Sir David Salomons, Bart., Major-General Webber, C.B. Hon. trustees: Mr. A. P. Trotter, B.A., 2, Victoria-mansions, 28, Victoria-street, Westminster, S.W., Mr. J. H. Thornton, chartered accountant, 227, Winchester House, Old Broad-street, E.C. Hon. secretary: Mr. James Swinburne, 49, Queen's-road, Wimbledon, S.W.

The issues raised are of the greatest possible importance, both to the public and to the medical profession, involving as they do the question of the *bonâ* or *malâ fides* of methods of treating disease by electrical or alleged electrical processes which have been and are now being carried out and extensively advertised under the auspices of Mr. C. B. Harness and the company with which he is identified.

A preliminary action has already been brought by Dr. Tibbits, at Mr. Harness's expense, against the *Electrical Review* for alleged libel, as he had been strongly censured in that paper for associating himself with the system alluded to.

The proprietors of the *Electrical Review* obtained a verdict with costs against Dr. Tibbits, but even if the *Electrical Review* succeeds in recovering the costs from Dr. Tibbits, the costs recoverable will only meet a portion of the expenditure necessarily incurred. It is intended to devote a portion of the amount subscribed to the payment of these expenses, which have been the result of a disinterested and, so far, a successful attempt to protect the public.

The committee further intend to apply such portions of the amount as they may, in their discretion, consider advisable to pay, or contribute to the payment of the expenses which have been, or may be, incurred by the proprietors of the *Electrical Review*, or by those of *Science Siftings* in connection with this litigation. Any surplus remaining after such payments have been made, may, at the discretion of the committee, be employed as the committee may determine in connection with any further proceedings that may be taken in the matter.

It is believed that members of the medical profession especially will be glad of the opportunity of expressing, by a liberal support of the fund, their disapprobation of the view put forward by Dr. Tibbits's counsel, that the article, in censuring Dr. Tibbits, was, in his person, attacking the medical profession generally.

If any of your readers are willing to subscribe to the fund, and to give it the benefit of their influence and support, they are requested to forward the amount of their subscription by cheque, payable to Mr. James Swinburne (Defence Fund), and crossed London and South-Western Bank, Wimbledon Branch.—Yours, etc.,

JAMES SWINBURNE, Hon. Secretary,
49, Queen's-road, Wimbledon.

TIBBITS *v.* ALABASTER AND OTHERS.

SIR,—I have read with pleasure the able article on the above case which appears in the last issue of the *Electrical Engineer*. The medical as well as the electrical professions certainly owe a debt of gratitude to the *Electrical Review* for their fearless exposure of electro-medical quackery.

Unfortunately, those members of the British public who most need protection do not read scientific publications, and therefore the articles which have appeared in the columns of your contemporary check to a very small degree only the flourishing trade of the electro-medical quack.

Allow me to suggest that a small pamphlet, containing a condensed report of the above case, should be issued and well advertised in those daily papers which contain the quackery advertisements.

If a pamphlet such as I have suggested were issued under the patronage of leading members of the medical and also electrical professions, and intending purchasers of so-called electropathic belts were invited to invest a sixpence or a shilling before parting with their sovereigns, in a very great many cases they would, I believe, be induced to do so, and in this way the roaring trade which is now being done by the advertising electrical quack would receive a very considerable check.

The pamphlet would, I believe, pay its cost, and I should hope it would also yield a commercial profit.—Yours, etc.,

S. ALFRED VARLEY,
53-54, Chancery-lane, W.C., Feb. 28, 1893.

(For remainder of Correspondence see page 239.)

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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COMING EVENTS.

Two sentences in the chairman's speech at the meeting of the Liverpool Electric Supply Company are worthy of more consideration than they will probably receive. There is an old saying that forthcoming events cast their shadows before, and we shall probably, during the whole of this year, be continuously hearing of the lapse of the incandescent patents. One of the sentences to which we refer is upon this subject. We may give the context of the important sentence to the effect that "on the subject of the cost, no doubt it is still expensive, but I am assured our customers, the public consumers, may soon have the light very much more cheaply. We shall be enabled to furnish it more cheaply *if a certain new lamp that is being invented*, and will come into use when the patents of these particular lamps run out; with that lamp we shall be able to give our customers the light very much more cheaply."

This is, of course, somewhat indefinite, and not much reliance may be placed upon a lamp which is being invented, but it shows that on every hand investigation is being made to see if competition will not reduce, at any rate, the cost of the incandescent lamp. We have not the slightest hesitation in saying that it will, but we do not think that competitors will, at any early moment, be able to make much impression upon the business of the Edison-Swan Company. It must be remembered that they in their manufacture have had the experience of years, and although a specification of a patent may be termed to be the basis of the manufacture, it is almost certain that the actual process of manufacture is far more important than the patent itself. The experience gained in the process of manufacture by a company which has turned out millions of lamps, will not be overthrown in a day by the experience of new manufacturers. The old company will no doubt meet the new competition by a general decrease of prices, and then the consumers will have to determine whether they will support a lamp which, to say the least of it, has been tested practically during the course of years, or the new lamp which is put into competition and has had no practical test. The mere price of a lamp is not the only criterion which should determine the purchase of a lamp. We have not, however, at the present moment to enter into what constitutes a good or what constitutes a bad lamp, but merely to call attention to the tendency of the day, which is to prepare for the lapse of the patent.

The other sentence to which we refer forms a text that we should like to see presented, not only to every consumer, but to every non-consumer of electrical energy. It is the statement of the consumer to the effect that "if we had to pay three times as much, we should have the electric light." This is a moral which we have for years desired to see. The advantages of the electric light have been placarded before the public, but they have not as yet realised that the cost, as compared with gas, is only one among several things to be considered. It would not be amiss if at the various general meetings of the companies the opinions of consumers were freely given, and we think, in the majority of instances, it would be found that the consumers preferred to pay a larger sum directly than to return to gas. The paying of a larger sum directly does not mean that the cost of the electric light is in the long run greater than the cost of gas; the comparison is not fair when the gas bill and electric light bill for any three months are put together to see which totals up the largest amount.

THE TELEPHONE QUESTION.

We should not have touched upon this question again were it not doubtful whether our esteemed contemporary the *Electrical Review* and ourselves agree upon a fundamental point. In our issue of February 17 we said that the Glasgow exchange was being converted to the *Mann* system. We italicise *Mann* because of its importance. Our contemporary assumes that *Mann* is the equivalent of *Law*, an assumption we courteously but emphatically deny. We are not called upon to defend Mr. Bennett, but we should not be surprised if he were to state that he has always condemned the Law system, and held it to be impracticable for practical purposes. He would no doubt argue, that the system he supports is the Mann system, which, it may be, bears a superficial resemblance to the Law system, but at the same time is different. Before, then, we can argue upon the same platform, it is necessary to agree upon the similarity or dissimilarity of the "Mann" and "Law" systems. If they are the same our case is gone; if they are not the same, the criticism of our contemporary in its last issue is beside the mark. We are quite ready to assure our contemporary that its "policy on this telephone question has been to some difficult to understand." Surely a policy is determined by the broader questions under discussion, rather than matters of detail. It seems to us that these broad questions are somewhat limited, and might even be reduced to two: (1) Metallic or earth returns; (2) underground or overhead wires in London. No doubt if asked categorically, our contemporary would prefer metallic circuits and underground laying. It might also admit that had there been no signs of opposition, the National Company would have waited for the millennium before approaching the consideration of these questions.

WHY PROCRASTINATE?

"Repetition" is a word dear to the schoolmaster, but it is sometimes forgotten by the journalist. The whole world is not edified by the writing of a sentence, however true the sentence may be. The success of the electrical industry largely depends upon the action of members of local authorities. If these men know of what they are talking when discussing lighting schemes, so much the better. Unfortunately, however, their words too often indicate that they are totally ignorant of the most elementary notions of the subject. It is the men beclouded with ignorance who most frequently speak and vote for procrastination. For years, with the utmost regularity, local authorities have had dunned into them the statement that "electric lighting is yet in its infancy"—wait and see what time will bring forth; in other words, do nothing to improve the present state of things, because, perhaps, a century or two hence improvements not now dreamt of will have been made. Thank goodness, this "infancy" business is rapidly dying out. It is incumbent upon us, however, to help it out of existence as quickly as possible; hence when we find responsible members of local bodies, as at Lambeth, suggesting procrastination because of the rapid improvements being made, we are inclined to ask:

"... do I dream,
Or is visions about?"

Improvements are being made in all branches of electrical work—of that there can be no doubt; but the point is, are such improvements being made, or likely to be made, as should cause buyers to hesitate before buying? Most emphatically, no. The improvements to be made are improvements in details, and are somewhat of the same importance as improvements in steam-engines. No one puts off buying a steam-engine because, as a piece of machinery, it is imperfect. We all know improvements will be made, but the improved engine is only fractionally better than the one now obtainable. Similarly, in electric lighting and electric engineering work generally, no improvements of a sensational character are likely to come soon enough to detract from the value of the apparatus to be obtained now. Oh, ye opponents of progress, consider whether you cannot find some more worthy reason for opposition than "in its infancy," or "wait for coming improvements."

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

XII.

(Continued from page 103.)

SLIDE RESISTANCES, *continued.*

Muirhead's Improved Slide Resistances.—Working on the principle of Thomson and Varley, Dr. Alexander Muirhead, of Westminster, has recently introduced a novel form of Slide Resistance Coil, which possesses several advantages over the older examples. Among these may be mentioned its greater compactness, increased facility of using and reading, and greater simplicity of construction. For a set of resistances to have a total resistance of 100,000 ohms and to vary by steps of 10 ohms, 201 coils all carefully calibrated are required with the original Thomson and Varley design, and only 43 coils when the instrument is made on Dr. Muirhead's plan, so that the cost of construction is considerably reduced in the latter case.

The principle involved is just an extension of that employed by Thomson and Varley, but instead of having only two dials with 101 and 100 coils respectively, the second dial acting as a vernier to the first, Dr. Muirhead employs three or four or more dials all mounted in the same frame, each one (with the exception of the first) acting as a vernier to the one preceding it.

Fig. 31 represents a general view of Dr. Muirhead's instrument, and Fig. 32 is a diagrammatic plan view of the under-side of its upper part, showing the four sets of coils with their fittings and connections. As in the case of the Thomson and Varley slides, described in the last article, th instrument illustrated in Figs. 31 and 32 has a total resistance of 100,000 ohms, altering by steps of 10 ohms at a time; and, as shown in Fig. 31, the four dials are marked on the top plate, thousands, hundreds, tens, and units, respectively.

It ought to be remembered in dealing with Fig. 32, that it is strictly a diagrammatic illustration to show the principle of the instrument and its under-board connections, without showing to scale the actual positions of all the fittings. The coils in the dials, for instance, have been drawn as if they occupied only about two-thirds of the circumference of the circular platforms on which they are mounted, whereas in the actual instrument they are so arranged that they occupy practically the whole of the circumferences.

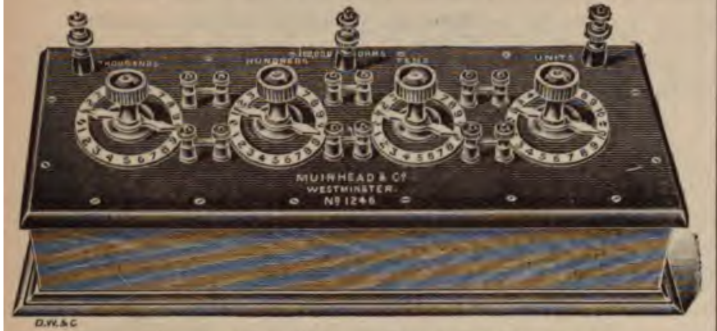


FIG. 31.—Dr. Muirhead's Slide Resistance Dials.

The values, etc., of the coils in the four dials are given in the following table. Dials A, B, and C have each eleven coils, nine unshunted and two shunted, and dial D has ten coils all unshunted. The fractions of the whole current passing through the shunted and unshunted coils of each dial are given in the last two columns of the table.

Dial.	No. of Coils.			Resistance of each Coil. Ohms.	Proportion of Current Passing through	
	Unshunted.	Shunted.	Total.		Unshunted Coils.	Shunted Coils.
A	9	2	11	10,000	Whole	One-half
B	9	2	11	2,000	One-half	One-fourth
C	9	2	11	400	One-fourth	One-eighth
D	10	0	10	80	One-eighth	—

The dials can be all isolated from each other by removing the junction-bars, s_1 S_1, t_1 T_1, s_2 S_2, etc., shown in Fig. 31, and dotted in Fig. 32; and by making connections to the terminals M and N, S_1 and T_1, S_2 and T_2, S_3 and T_3, each dial may be used separately as a variable resistance.

Referring to Fig. 32, and the table given above, the principle underlying this instrument may be explained as follows: When all the bars s_1 S_1, t_1 T_1, s_2 S_2, t_2 T_2, s_3 S_3, and t_3 T_3 are disconnected, the total resistance between the terminals S_3 and T_3 is equal to

$$10 \times 80 = 800 \text{ ohms};$$

and that between s_3 and t_3 is equal to

$$2 \times 400 = 800 \text{ ohms}.$$

But if the two connections s_3 S_3 and t_3 T_3 are inserted, there are now two paths of equal resistance between s_3 and t_3 (or between S_3 and T_3), so that the virtual resistance between these two points becomes just equal to the half of either, or 400 ohms.

Still keeping the other two pairs of junctions out, the resistance between S_2 and T_2 will now be equal to

$$\begin{aligned} &9 \times 400 \text{ ohms} + \text{the resistance between } s_3 \text{ and } t_3, \\ &= 3{,}600 + 400 \text{ ohms}, \\ &= 4{,}000 \text{ ohms}; \end{aligned}$$

while that between s_2 and t_2 being equal to

$$2 \times 2{,}000 \text{ ohms, is also} = 4{,}000 \text{ ohms}.$$

When now the second pair of junctions s_2 S_2 and t_2 T_2 are inserted there are again two paths of equal resistance, so that the resistance between s_2 and t_2 becomes halved as before, that is = 2,000 ohms.

Again, before the junctions s_1 S_1 and t_1 T_1 are inserted, we have, as in the other two cases, two equal resistances,

$$\begin{aligned} S_1\,T_1 &= 9 \times 2{,}000 \text{ ohms} + \text{the resistance between } s_2 \text{ and } t_2, \\ &= 18{,}000 + 2{,}000 \text{ ohms}, \\ &= 20{,}000 \text{ ohms}; \end{aligned}$$

$$\begin{aligned} \text{and } s_1\,t_1 &= 2 \times 10{,}000 \text{ ohms}, \\ &= 20{,}000 \text{ ohms}. \end{aligned}$$

Thus when the last pair of junctions s_1 S_1 and t_1 T_1 are inserted, the resistance between s_1 and t_1 becomes halved as in the two previous cases, that is equal to 10,000 ohms.

The total resistance between (M) and (N), that is between the two extreme terminals M and N, is therefore equal to

$$\begin{aligned} &9 \times 10{,}000 \text{ ohms} + \text{the resistance between } s_1 \text{ and } t_1, \\ &= 90{,}000 + 10{,}000 \text{ ohms}, \\ &\text{or } R_2 + R_3 = 100{,}000 \text{ ohms}. \end{aligned}$$

This result might also have been arrived at in the following way, knowing that at each of the junctions the current has a choice of two paths of equal resistance:

$$\begin{aligned} &R_2 + R_3 \\ &= 9 \times 10{,}000 + \tfrac{1}{2} \times 9 \times 2{,}000 + \tfrac{1}{4} \times 9 \times 400 + \tfrac{1}{8} \times 10 \times 80, \\ &= 90{,}000 \quad + 9{,}000 \quad + 900 \quad + 100, \\ &= 100{,}000 \text{ ohms}. \end{aligned}$$

The details in the construction of this instrument have been worked out in an entirely different manner from those of Thomson and Varley's apparatus. Each set of coils is mounted on a circular ebonite platform beneath the baseboard, as shown in the under-view Fig. 32; and the axis of each platform is continued through to the upper side where it is fitted with a handle by which each set of coils can be turned to a limited extent round its axis. The junctions of the adjacent pairs of coils terminate in a series of pins projecting radially round the edge of the circular platform as shown, and engage with the spring contacts (s_1), (t_1), etc., which fulfil the functions of the double and single arms in the original apparatus. The spring contacts for the first three dials are so set that they always span a pair of coils, just as in the double-arm dial of the original instrument; while the spring contact of the fourth dial, which is connected by a thick under-board copper strip to the centre terminal P, fulfils a function similar to that of the pointer in the single-arm dial. Each platform is provided with a flat bent spring which engages with the pins at the other side of the platform from the spring contacts, so placed that it brings the set of coils to rest, only when the spring contacts are exactly over their corresponding studs.

The spindle of each set of coils is fitted with a double

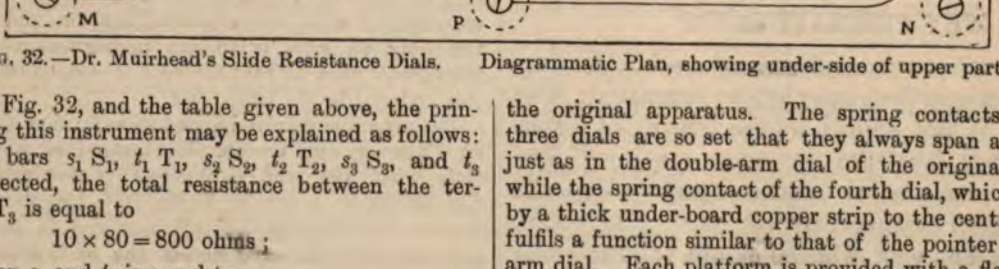


FIG. 32.—Dr. Muirhead's Slide Resistance Dials. Diagrammatic Plan, showing under-side of upper part.

pointer, as shown in Fig. 31, so arranged that it indicates simultaneously on a graduated circle fixed on the baseboard, the readings both of R_2 and R_3; and thus these values can both be read off directly, whenever the coils have been properly adjusted in making a measurement.

The whole is fitted in a box, as shown in Fig. 31, in such a way that all the coils and working parts are enclosed, so that they are not liable to damage from careless handling. The connections of the battery, galvanometer, etc., for making a measurement, are precisely the same as for the Thomson and Varley combination, and are illustrated diagrammatically in Fig. 28, page 102.

(To be continued.)

SHIPS' ELECTRICAL FITTINGS.

SIR,—We notice in your issue of 24th February a paper by Mr. L. Newitt, of Messrs. Sir W. G. Armstrong and Co., read before the North-East Coast Institution of Engineers and Shipbuilders, on "Ships' Electrical Fittings for Lighting, Signalling, Telegraphing, and for Motive Power."

In this paper are described and illustrated certain electrical telegraphs, known as the system of Captain Lloyd. Immediately following the description reference is made to Fig. 7, as "illustrating the instruments and circuits of a complete set of electric telegraphs as fitted on board a battleship," in such a way that your readers would, in all probability, infer that the ship, as shown, had been fitted up on Captain Lloyd's system, whereas such is not the case.

The diagram is intended to represent a battle-ship as fitted on our principle, with Fiske's range finders, Spratt's speed and direction indicators, and a complete set of Willis and Robinson's electric engine-room, steering, revolution, and range telegraph.

On this diagram in Mr. Newitt's paper, which he has kindly sent to us, we find that our name is given, but, in copying the diagram, you have probably overlooked it.

We shall be glad if you will insert this letter in your next issue.—Yours, etc.,

ELLIOTT BROS.

COMPANIES' MEETINGS.

LIVERPOOL ELECTRIC SUPPLY COMPANY, LIMITED.

The tenth annual ordinary general meeting of the shareholders was held on Friday last in the Exchange-buildings, Tithebarn-street, Mr. A. H. Holme presiding.

The **Chairman**, in proposing the adoption of the Directors' report, said: Gentlemen, before asking you to adopt the report and statement of accounts I propose to go through it and give you any information you may require on the different items. First of all you will see from the first paragraph that the business of the Company has very largely increased, the number of lamps we are supplying at present being 20,254, as against 14 966 last year. I am sure it must be a source of satisfaction to you to know that the business has been so much increased, more especially as with the increase of business we are able to give you an increased dividend. As far as concerns the dividend, we have come to the conclusion to give you 5 per cent. We have, of course, to provide for other things out of our gross profit, and we have written off £4,099 for depreciation, and placed £2,000 to the renewal fund, and this leaves us, after adding the balance brought forward, with £11,421. 19s. 11d. With your permission we propose out of this sum to pay a dividend at the rate of 5 per cent. per annum, which will take £8,621, to add £1,500 to the reserve fund, and to carry forward £1,300 to next year's account. We think that is as much as we can prudently afford, and we think we have allowed quite margin enough for all contingencies, and that is an honest dividend on the face of it, and not an extravagant one. We don't propose to give you sensational dividends, but a steady dividend, and not to have to go back to 3 or 4 per cent. Looking at the accounts, you may think probably that the amount put to depreciation for buildings is a small one—only £160—but we have kept the buildings in thorough repair; they are just as good for the purpose of this Company as they were when they were erected, and we think there is quite sufficient written off, though I may say that under this head, since the commencement of the Company, there has been £2,000 written off. Then there is the case of the mains. There seems to be quite an erroneous opinion amongst several gentlemen who ought to know better about the depreciation of the mains. They seem to think that electricity passing through them has the effect of depreciating the copper, but as a matter of fact the mains are practically immortal. It always maintains its value as copper, and though repairs are necessary as regards the covering of the mains, the amount we have written off for depreciation quite covers the repairs to be done each year, and I think the sum we have written off for mains and machinery—£3,868—is really quite enough for that purpose. I hope the shareholders will be satisfied with the dividend It is as much as we can afford to give, and I think quite as much as the business warrants. While speaking on this point I may say that we propose, with your consent, to pay an interim dividend. There is no reason why we should keep it till this time next year, and probably we shall pay it about September in each year. I do not suppose anybody will object to that. Then we come to the question of expenditure on capital account—what we propose to do to meet the proposed extensions, and to obtain the money we want for improvements. We are in such a condition now that it is absolutely necessary, with the demands made upon us by the public, which demands, under penalty, we are obliged to satisfy, that we should have additional mains, additional machinery, and more powerful engines, and larger dynamos. During last year our expenditure on capital account was £34,786, and was made up of three great items. First, the additional mains in our extended area. (I am sorry our map is on so small a scale.) You will see we have gone on in the direction of Abercromby-square as far as Prince's Park, and up to Falkner-square and London-road. We have spent this money in additional mains for that area, and replacing some small engines by more powerful ones, and in building a new station at Lark-lane. I think the expenditure has been justified; we were obliged to incur this, and we shall be obliged to incur more. We are looking forward, as you see by the report, to raising a further sum of £100,000, but we don't intend to raise it all at once, and the amount we shall raise will be ample with the nncalled money we have to last us for three or four years, as far as we can tell. We do not, as you will see from the report, call up this £100,000 all at once, but we intend to issue 5,000 shares, which will bring in £25,000, which will certainly last till the end of this year. These shares we propose to issue to our present shareholders. We propose to issue them in ordinary shares, and we shall ask for 10s. or £1 on application, and the rest in a month. I may say the qnestion of how we were going to raise this additional capital is one to which we have given very serious consideration. We have thought it over many times, and had a good deal of keen discussion on the subject. At one time we thought we would issue debentures, which we were assured could be very easily placed, but after consideration we came to the conclusion that our capital was a little too small yet to be saddled with a large sum in debentures, and that probably when we got it up to £300,000, as we must do in a year or two, we could then issue debentures on better terms. We also had to consider that our shares are now, and have been for some time, at a premium, and we thought the best course to adopt was to issue shares to the shareholders at par, and let them have the benefit of the increased prices in the market if they wished to sell them. There are, of course, different ways of looking at this sort of thing, and I think the Directors have regarded the matter from every aspect, and this is the conclusion they have come to. Referring to the Sefton Park station, that is a little thing in the way of au experiment, but we were very much besieged with requests from the inhabitants of Sefton Park and the neighbourhood, who said, "When are you coming to light Sefton Park," and so, after consideration, we secured a piece of land, built our station, and it is practically now at work. I may say that I do not think the Sefton Park station will pay us any considerable dividend for this year, but I certainly think it will pay its working expenses, and afterwards become a very profitable station when the people have got accustomed to it. I may say a word as to the trouble we have with local authorities — that is, the Toxteth Park Local Board, and even the Corporation of Liverpool. The officials are all very good to us, and anxious to help us as much as they can, and I must also say that the individual members of the different authorities are also anxious to help us, but when they get into a committee collectively they seem to regard us as their natural enemies, and do all they can to hinder us getting on with our work. I hope my remarks are not ungracious, for lately the Corporation have treated us better, and we have succeeded in getting them to do what we require in Sefton Park, and I think we have also nearly made arrangements with Toxteth Park Local Board, and we hope shortly to go on with the work. It is very annoying, as in Sefton Park some of the people have had their houses fitted for electricity, and their fittings and their lamps are there, and they ask us why we do not come with the light, and it must be my apology to them, and my answer to you to-day, to say that it is through the action of the local boards that we have not been able to give them the light. However, that has now been overcome, and I hope we will have no more trouble with them. Then, in connection with matters municipal, it is very pleasing to contrast this with the conduct of our kind and hospitable Mayor—the new Mayor we have had this last year, who has distinguished, if not illumined his mayoralty by being the first mayor of the city to have the electric light put into the Town Hall. Assuredly it is a source of great satisfaction to us to think we have at last stormed that stronghold. The principal ballroom, and also the Council-chamber, are now lit with the electric light, and, I think, will be for all time to come. We have only just made our way in, for the rest of the building is in comparative darkness on account of the use of gas. We hope to get those later on, and also we shall probably receive an order to experiment on Castle-street to see what we can do in the way of street-lighting. I do not think I have any more to say except to congratulate you on the result of our year's work. I think we have done fairly well, for not alone are you having a tolerably fair dividend, but I think you are also doing a great deal of good in the town. I do not know whether you wish to pose as philanthropists, but I think the introduction of light in offices and banks has done a great deal of good. In fact, I believe now that some of the banks could not possibly do without it, as the clerks had so much bad health previously, and as well as the philanthropy, we can give you 5 per cent. I think you ought to be tolerably well satisfied. I heard a large shareholder the other day belonging to an important insurance company say "If we had to pay three times as much we should have the electric light." On the subject of cost, no doubt it is still expensive, but I am assured our customers—the public consumers—may soon have the light very much more cheaply. We shall be enabled to furnish it more cheaply if a certain new lamp that is being invented, and will come into use when the patents of these particular lamps run out; with that lamp we shall be able to give our customers the light very much more cheaply. I was very pleased to see in the papers the day before yesterday that the chairman of the gas company said that the quantity of light they were supplying was increasing. It is very pleasant to see this, for there is nothing but a very healthy rivalry between us, and it is pleasant to see that there is not only more gas, but more electric light—in fact, more light all round, and that is a very good thing. You will see we have a capital of £200,000, less £45,000 uncalled. Of that uncalled capital £20,130 has been paid up. When we were thinking of issuing debentures we sent a circular round to ask gentlemen who held those shares who chose to pay up the difference might do so, and the result was that £20,130 was paid up, and the balance is uncalled. I do not know whether the shareholders will like to express an opinion as to whether we ought to call the rest of that money, or to allow people to have the option. We are giving them that because we thought of issuing debentures, but probably they will leave the matter to the Directors, and I think we will give those shareholders who have not paid up the opportunity of doing so. The other items explain themselves. On the other side you will see the depreciation taken off is £4,099, the conditions being on the cost and on the Board of Trade license. That is an old matter, on which we write a little off every year on the advice of our auditors. I do not think I need say any more, and I would like to answer any questions.

The motion having been formally seconded, a **Shareholder** asked whether the new shares were going to be issued *pro rata* to the shareholders, and the **Chairman** replied in the affirmative.

Mr. Lister congratulated the Directors. They had a long period of hard and anxious work, and they deserved the fullest credit for the trouble they had taken. He was happy to be in a position to corroborate all the Chairman said about the gas company, and so far from there being any jealousy, there was a feeling of thankfulness to the electric light company for having educated the public to the use of more light.

Mr. C. Birchall also congratulated the Directors, and regretted that their Chairman's example of giving the fullest information to shareholders was not more wide adopted. He suggested that the needful £25,000 might be raised by calling in the remainder of the uncalled capital. Of course, this was a matter of opinion; but many of the shareholders might be only too glad to take up the balance of their shares. He considered the policy of only paying a 5 per cent. dividend at present as a very wise one, for anything in the shape of sensational dividends was to be deprecated, and would lead to considerable trouble, and probably bring the Company into disgrace and discredit.

Mr. Kenion complained of the absence of a profit and loss account in the statement sent to shareholders, but the Chairman handed to the speaker a printed copy of the profit and loss account, and said it was only circulated privately amongst the shareholders, as they did not want to give themselves away altogether to the public, although there was really nothing to conceal.

Mr. Kenion then said he was glad to hear that they proposed to reduce the cost of supplying the light. Speaking as a small consumer, he could say that the electric light cost him nearly 50 per cent. less 12 months ago than it did now. He had been told that this was due to an alteration of the standard, which was made in order to induce small consumers to take the light, but he had gone into the matter, and had found that a consumer would have to take less than 11 volts per month before receiving any benefit from the change. He also complained of the custom of rendering monthly accounts.

A **Shareholder** asked at what rate did the Directors allow for depreciation? It was not so much a question of the wearing out of material they had to deal with as the supercession of the different parts of the plant.

The **Chairman** said they allowed 1½ per cent. on the mains, and about 4½ or 5 per cent. on most of the machinery. They had written off £9,000 altogether for the machinery and mains since the formation of the Company. The Directors thanked Messrs. Lister and Birchall for their congratulations, and with regard to the raising of the £25,000, they thought it best to hold the uncalled capital in reserve for the present. Their bankers were very good to them, having frequently allowed overdrafts, and this uncalled capital gave them a little security. The whole matter had been very carefully considered. With regard to the price of electricity, and other technical matters, he would call upon their manager, Mr. Holmes, to explain. The success of the Company was largely due to Mr. Holmes, whose knowledge of his profession, and capital business capacity, had largely contributed to the good fortune of the Company.

Mr. A. B. Holmes, the managing engineer, said that the price the Company charged last year was regulated by a sliding scale, which averaged about 8d. per unit. That was the same for a large consumer as a small consumer, and the only difficulty about it was that no one understood it. The consequence was that the time of his staff was taken up in explanations. They therefore came to *the conclusion that they* would adopt the simple scale of the gas company, and this, far from being a disadvantage to the consumers, had considerably reduced the Company's receipts. As far as he knew there were only two cases of people giving up the light on account of the new scale. With regard to the reduction in price, they would not be able to lessen the cost of production, but if they could get a lamp which would give them the same light at two-thirds the amount of electricity, the consumer would benefit, and the Company would have to recoup themselves in increased business. One probable source of revenue in the future was in the supply of small powers. They were already supplying some people with 30 h.p., and there were others who would doubtless find that with limited space this was the best motive power they could use. Then they had 15 or 20 ventilating fans, which were giving great satisfaction, and he thought they would be able to use electricity for hoists and other matters, because in all cases where the power required was intermittent and only occasional, electricity could beat either steam or water. With regard to the accounts, it was found more convenient to render them monthly, but there was no trouble about consumers being allowed to arrange to pay quarterly.

The report and statement of accounts were then adopted, and the **Chairman** moved the payment of a dividend of 5 per cent. per annum, free of income tax, and said that this would be paid in a week

Sir David Radcliffe seconded the motion, and it was unanimously carried.

On the motion of the **Chairman**, Mr. Banner and Sir D. Radcliffe were re-elected to the directorate.

On the motion of **Mr. C. Birchall**, Mr. W. L. Jackson was reappointed auditor.

Mr. Lister moved that the remuneration of the Directors be fixed at 750 guineas, and this was seconded and unanimously carried.

The **Chairman** then moved that the next ordinary meeting of the shareholders be held on or before March 31, 1894, and this was agreed to.

This concluded the business of the ordinary meeting, and an extraordinary general meeting was at once formed, and the following resolutions formally agreed to: "1. That the capital of the Company be increased to £300,000 by the addition thereto of 20,000 shares of £5 each. 2. That provisions of the Forged Transfer Acts, 1891 and 1892, be and they are hereby adopted by and made applicable to this Company, and that compensation be made out of the funds of the Company for any loss arising from the transfer of any share or security of the Company in pursuance of a forged transfer, or of a transfer under a forged power of attorney."

A vote of thanks to the Chairman brought the proceedings to a conclusion.

TELEGRAPH CONSTRUCTION COMPANY.

The twenty-ninth ordinary general meeting of the Telegraph Construction and Maintenance Company, Limited, was held on Tuesday, at the offices, 38, Old Broad-street, Sir George Elliot (chairman) presiding.

In moving the adoption of the report, the **Chairman** observed that he dared say that that part of the report which dealt with the reduction in the dividend, which they had been able to pay with unusual regularity for many years past, was what had most attracted the attention of some of the shareholders; but, while the Directors sympathised with them in the circumstances, there was nothing, he thought, to cause surprise or uneasiness. It was mainly due to the exceptional year they had passed through as regarded cable operations, no large works having been undertaken. It was also in part due to a falling off in their general business.

The motion was seconded by **Mr. G. W. Campbell**, and agreed to without discussion.

NORTHAMPTON ELECTRIC LIGHT COMPANY.

The fourth annual meeting of the shareholders of the Northampton Electric Light and Power Company, Limited, was held at the Town Hall last Friday. The Directors reported that the business of the Company continued to increase, and the electric light was steadily making its way. At the present time there were more than 4,000 8-c.p. lamps, or their equivalents, connected with the Company's mains, and not a few of the original customers had shown their appreciation of the light by extending its use. The debentures referred to in the last report, amounting to £5,000, had all been taken up, and the interest upon them had been punctually paid. After providing for debenture interest, there was a balance of profit this year of £87. 15s. 1d , which would go in reduction of the deficiency occasioned last year by working expenses having been incurred for some months before the accession of customers. The third engine-set would be shortly in working order. To meet the additional cost it had been resolved to issue 6 per cent. cumulative preference shares to the extent of £5,000. These shares had been allotted to the extent of £3,180. The Directors had been fortunate in securing some property adjoining the Company's works in Angel-lane for the erection of coal-sheds, which would result in a substantial saving in the way of cartage, and there would be abundant room for any future extension of the works. The chief engineer, Mr. B. R. Beale, had given up his position, but most kindly continues to devote a considerable amount of time and energy to the promotion of the Company's interests. He was succeeded by the second engineer, Mr. W. E. Heenan

The report was adopted, and Messrs. Seckam and Manfield, the retiring directors, were re-elected.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual ordinary general meeting of this Company was held yesterday at the central station, Draycott-place, Chelsea, under the presidency of Mr. J. Irving Courtenay (chairman). The Secretary (Mr. S. J. Cluer) having read the notice convening the meeting,

The **Chairman** said: Before moving the adoption of the report and accounts, I will direct your attention to some points that seem to me worthy of special consideration, and will say a few words on the general position of the Company. The net revenue for the year after deducting debenture interest is £1,336. 2s. 7d., out of which it is proposed to pay a dividend on the ordinary shares of 2½ per cent. This is not a large dividend, but it is in addition to the payment of a heavy debenture interest, and may be taken as an earnest of the future. You are aware that a considerable portion of this Company's capital is in the form of debentures. I will point out here that the net profits in 1891 were only 7½ per cent. of the gross, but in 1892 the net profits were 31 per cent. of the gross. The improvement in the Company's position which we looked forward to has now to some extent been attained, and you will observe that the gross revenue approximates to the estimate I gave last year. The substantial progress made each year in the profits is shown by the fact that the debenture interest provided for in the last three years was in 1890, £530; in 1891, £1,206; and in 1892, £1,843, in addition to the net profit just mentioned. You will notice that as our capital expenditure has increased, so also have our profits increased in a much larger proportion. The increase in capital expenditure is moderate in comparison with the figure it may reach before we arrive at the limit of profitable expenditure in Chelsea. The capital expenditure equals £2. 6s. 6d. per lamp installed, which will compare favourably with the capital outlay of any other electric lighting company. We have increased the number of our lamps during last year without any large extension of the mains, and the percentage of increase in the revenue has been nearly as large as the increase in the number of lamps. The other items in which the capital has been laid out have entirely justified the expenditure by the benefit already accrued, and we have the best reasons for expecting a still larger return on this expenditure during the current year. Besides some extension in mains, the enlargement of existing mains, and the necessary addition to our stock of meters, we have added to our plant two boilers and a pair of feed-water heaters; we have built an extra bunker for the storing of coal, an additional exit from the engine-room in case of accident, and we have made some additions and alterations to all the boilers which have been productive of large economy in working. We have enlarged the building of our Clabon-mews sub-station, and placed there an additional continuous-current transformer. These transformers were supplied by the Electric Construction Corporation, Limited, and have continued to work in an eminently satisfactory manner. They are used in addition to the accumulator plant, and not in substitution for it; and we have found that the combination entirely fulfils the expectations formed at the time of the original design of the system by Mr. Frank King—a system which enables us to afford our customers a regularity of supply nowhere surpassed. The plant has been maintained in a thorough condition; indeed, the nature of the business is such that were this not done the supply could not be kept up. The storage batteries are in excellent condition, and the mains, of Callender's bitumen cable, have stood the test of now nearly four years underground, the insulation being still quite satisfactory. On a former occasion when I addressed you I alluded to the heavy consumption of coal, and stated that it was not due, in my opinion, to any fault in the Chelsea system. The words I then used are now being justified. The Directors have continued to give unremitting attention to this point, and have succeeded, with the able assistance of Mr. King, who has been appointed managing engineer, in tracing the causes and in remedying the defects in the plant. Some of the improvements suggested and carried out by Mr. King were not completed very early in 1892, and we are therefore warranted in looking for better results at the end of the present year. With the experience gained, we do not doubt that further economies can be made. As you will have observed in the report of the Directors, the amount paid for coal in 1892 is 9½ per cent. less than that paid in 1891, although the amount of electricity sold in 1892 is 23 per cent. more than in the previous year. Not only has there been a saving in coal, but there has been greater economy all along the line. The cost of coal, water, and engine-room stores taken together has been 1d. less per unit of electricity sold, and the total cost of the unit, including all general charges, has been 1½d. per unit less than in 1891. You will expect to hear something from me regarding the decision in the law courts on the three-wire system. In Chelsea, our supply is on two wires only, and in the small portion of Kensington served by this Company, the system is such that it is our belief that it cannot be brought under the operation of Mr. Hopkinson's patent. Now the proposed transfer of the Kensington portion of our area was the cause of the extraordinary general meeting held on the 14th ult., when the policy of the Directors in regard to that matter was unanimously approved. I wish the shareholders to clearly understand what this amounts to, because I observe in some of the papers erroneous statements are published that we were transferring our Chelsea order and business. This is not so. The transaction is strictly limited to the small portion of Kensington, and does not in any way deal with the Chelsea district. As stated at that meeting, the Directors consider that the transfer will be beneficial to both companies, owing to the position of the two generating stations relatively to the area. The price agreed upon is a fair one, and the capital thus set free will be of material assistance in extensions in our Chelsea area, so as to cope with the demands arising in the immediate future. I think I have gone over the principal points, and I would say that the prospects of the Company are now better than ever, both as regards profits and increase of business. The district in which our mains are laid is rapidly filling up with customers, as those of you who are residents in Chelsea will know, and no one when once supplied by our system cares to discontinue its use. Close around us new houses are everywhere being built, and in many of them, I am informed, no prevision is made for gas. Such is the confidence earned by careful attention to the quality of the supply. Residents who have tried several systems say that none is better than that given by our Company. You will thus see that we cannot stand still, but must be always moving forward, giving the strictest attention and using strict economy as to the direction in which any new capital is spent, and continuing to make such additions and improvements in plant as will ensure the largest economy in the daily work of supply. We have a good future before us if we succeed in making judicious use of our opportunities, and I hope that our endeavours will be cordially supported by the shareholders I now beg to move that the report and statement of accounts now before the meeting be adopted, and that the payment of a dividend for the year 1892 at the rate of 2½ per cent. on the ordinary share capital be approved and made payable on the 15th April.

Major-General Webber, C.B., in seconding the motion, fully endorsed all that the chairman had said. He mentioned that their expectations had been fully realised during the past year, and he believed that their anticipations for the future would be attained to even a greater extent.

The motion was then put to the meeting, and was adopted.

The retiring directors, Sir George Prescott, Bart., and Mr. E. Garcke, were, on the motion of the **Chairman**, seconded by **Mr. Jillings**, re-elected, as were also Messrs. Cooper Bros. and Co., the auditors. This concluded the business at the ordinary meeting.

An extraordinary general meeting was then held, when the following resolution, passed at the extraordinary general meeting held on the 14th ult., was confirmed:

"That the Bill proposed to be introduced in Parliament in the ensuing session, and now laid before this meeting, intituled: 'A Bill for confirming an agreement for the transfer to the Kensington and Knightsbridge Electric Lighting Company, Limited, of the undertaking of the Chelsea Electricity Supply Company, Limited, authorised by the South Kensington Electric Light Order, 1889,' be, and the same is, hereby approved subject to all such additions, alterations, and variations as Parliament may think fit to make therein."

A vote of thanks to the Chairman brought the proceedings to a close.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The annual meeting of this Company took place at the Depôt, Darlaston, on Wednesday. Mr. W. J. Carruthers-Wain took the chair, there being also present Messrs. C. James (deputy-chairman), W. Busby, and F. H. Lloyd (directors), Mr. G. Elliot (solicitor), Mr. H. Hatchett (secretary), Mr. A Dickinson (general manager and engineer), and a large number of shareholders.

The Secretary read the notice convening the meeting, and also the following circular which had been issued by the chairman to the shareholders: "Darlaston, 27th February, 1893. Dear Sir,—Possibly I may save you a fruitless journey to Darlaston on Wednesday next, the 1st prox., by informing you that I intend to move the adjournment of the meeting on the following grounds: 1 A libellous circular, full of misleading statements, has been secretly and at the last moment issued to certain selected shareholders, but not to the Directors or officers of the Company. 2. Many of the shareholders whose names appear in the circular have written me disavowing all responsibility for its statements. 3. The Board will issue a full and categorical reply to the circular. 4. I propose to commence an action for libel against such members of the self-constituted committee as do not repudiate the circular, so that an opportunity may be given to investigate the facts before a judicial tribunal, and not before a committee instigated by interested and designing agencies. 5. As an illustration of the gross misrepresentations of fact, it may be mentioned that instead of the self-appointed committee holding £10,000 in the Company, as they allege, their holding is actually £3,740.—I am, etc., W. J. Carruthers-Wain, chairman.

A short and stormy discussion was held, and the meeting resolved by an overwhelming majority to adjourn.

The report of the Directors for the year ended December 31 last states: The receipts have increased by £656. 13s. 7d. over those for the 12 months to December 31, 1891, and were 13·47d. per mile run, as compared with 14·03d. for the previous year, and the average fare per passenger carried was 1·50d., in comparison with 1·52d. for 1891. The total expenditure has decreased by £311. 8s. 11d., and is at the rate of 11·90d. per mile run, as compared with 12·86d. in the previous year. The profit on the working amounts to £3,172. 19s. 8d., to which must be added the amount of £1,064. 12s 9d. brought forward from last year, less the amount of £600 placed to reserve and renewal account, and after providing £1,781. 11s. 8d., the amount due for interest on debenture bonds, and £57. 12s. 8d for income tax, a balance remains of £1,798. 8s., of which, following the auditors' recommendation, it is proposed to carry £1,200 to the reserve and renewal fund, and the balance of £598. 8s. 1d. carried forward to the next year's account. Your Directors are glad to be able to announce the completion of the conversion of the steam-worked tramway between Wednesbury, Darlaston, Walsall, and Bloxwich into a system of tramways worked electrically by the overhead system of wires, and these lines (7½ miles) were opened for traffic on the 1st ult. The work appears to be satisfactorily executed upon sound principles, but your Directors must emphasise the long and what appears to be the unreasonable delay on the part of the contractors in completing the work. The prescribed penalties for the six months' delay, although amounting to a considerable sum, do not, in the opinion of your Directors, more than represent the loss sustained by the Company, and as at present advised such penalties can be rigidly enforced Your Directors have during the past year again approached the Birmingham Central Tramways Company in the hope that a through service into Birmingham might be arranged, but the Directors of that Company decline on any terms to grant running powers over their lines to this Company, but are, however, willing to continue their service of cable cars from the terminus of their line at Handsworth to Carter's Green, West Bromwich, a distance of nearly 2¾ miles of route, in the event of the conversion of this Company's lines between these points as a cable line, and your Directors having satisfied themselves that such an arrangement would be productive of mutual profit, are now arranging for an agreement. It is hoped that a definite statement on this subject may be made at the meeting. The Directors will do all in their power to effect an arrangement which will not only be immediately profitable to this Company, but will also remove the present acute difficulties with the Corporation of West Bromwich and the Handsworth Local Board respecting the use of steam, the power to use which ceases at an early date. The Directors deeply regret to record the death of their esteemed colleague, Mr. Chas. E Davison, who had been a director of the Company for many years, and whose intimate knowledge of tramway working was of much assistance in the conduct of the Company's affairs. The Directors have not filled up this casual vacancy, but they ask that the authority to do so may be continued to them. Under the provisions of the Companies Act, Mr William Busby, one of the directors, retires by rotation, and, being eligible for re-election, offers himself accordingly. The auditors (Messrs. Howard Smith, Slocombe, and Co., and Mr. William Stansfield) retire, and offer themselves for re-election. Proxy forms are enclosed for those shareholders who are unable to attend the meeting, and, to be available, they should be returned to the secretary by the 27th inst.

The revenue account shows that the working expenses amounted to £13,672. 19s. 5d., general expenses to £2,069. 16s. 9d., repairs £7,090. 5s., establishment expenses £1,196, 10s. 8d.—viz., Directors' fee £600, salaries £250. stationery £41. 18s. 6d.. travelling expenses £198. 1s., general charges £54. 1s. 2d., and audit fees £52. 10s., total £24,029. 11s. 10d., balance carried down £3,172. 19s. 8d.; grand total £27,202. 11s. 6d. The receipts were—passengers £25,871. 12s. 4d., contract tickets £398. 14s., mails £40, goods £414. 5s. 1d., parcels £106. 14s. 4d., transfer fees £8, advertisements £363. 5s. 9d., total £27,202. 11s. 6d The balance-sheet gives the following items: Nominal capital—ordinary stock £129,650., 8,658 preference shares £86,580; total £216,230. Capital issued—ordinary stock (less £2,005. 10s. calls in arrear) £129,650, 7,600 preference shares, fully paid, £76,000, debentures £49,830, creditors £3,314. 3s., reserve £5,065. 10s., balance of revenue £1,798. 8s. 1d.; total £263,652. 11s. 1d. On the other side are: Construction and equipment, amount expended as per last account, £247,110. 12s. 6d., expended since £12,994. 5s. 4d.; total £260,104. 17s. 10d.; horses £130. 3s. 9d., stores £952. 15s. 1d., rates and insurance £542 16s. 1d., debtors £934. 0s. 4d., cash in bank and in hand £987. 18s.; total £263,652. 11s. 1d.

The appended report of the general manager showed that the cars had run 484,462 miles, and carried 4,196,428 passengers, as against 454,126 miles run, and 4,002,246 passengers carried in the previous 12 months; whilst the receipts in 1892 were £26,270. 6s. 4d., as against £25,326. 3s. 7d. in the previous year. There had been carried 1,924 tons of goods, at an average price of $5\frac{2}{12}$d. per ton.

BUSINESS NOTES.

Dublin.—The present charge for electricity in Dublin is £1 per quarter for any quantity up to 30 units, £2 up to 60 units, and 7d. per unit above this quantity.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,232.

Charges in Glasgow.—The Corporation of Glasgow being now about to commence supplying electricity for private lighting purposes, has intimated that the price is to be 7d. per Board of Trade unit.

Aden-Zanzibar Cable.—The Eastern Telegraph Company, Limited, announce that the Aden-Zanzibar cable having been repaired, telegraphic communication is restored with Cape Colony and other parts of South Africa.

Ruthin.—At the Ruthin Town Council meeting on Tuesday, further information was ordered to be obtained as to the proposed electric lighting of the streets, and as to the terms upon which the gas company light the town with gas.

Crystal Palace Company.—At their last meeting, upon the recommendation of the committee, the Lambeth Vestry assented to the application of the Crystal Palace District Supply Company to extend the area given to them by the order of 1890.

Great Northern Telegraph Company.—This Company notifies that on and after the 1st prox. their rate to Canton, and other stations in China, will be reduced to 7s. a word, which will consequently be the rate to the whole of China.

Osler's Fittings.—The Empress Frederick, attended by Viscountess Downe and Count Seckendorff, visited Messrs. Osler's galleries in Oxford-street on Tuesday morning, and made purchases of some ornamental electric fittings for her new house.

City and South London Railway Company.—The receipts for the week ending February 26 were £943 against £834 for the corresponding period of last year, or an increase of £109. The total receipts for 1893 show an increase of £1,004 over those for the corresponding period of 1892.

Aberdeen.—Plans of new buildings to be erected in Cotton-street, and adjoining the gasworks, which are to contain the plant of the electric lighting scheme promoted by the Corporation, were passed at the last meeting of the Plans Committee of the Town Council. The erection will cost £3,500.

Waterloo Electric Railway.—The Bill authorising the construction of an underground electric railway from Baker-street to Waterloo Station came before Lord Morley on Tuesday, when formal proof of some minor amendments was given The scheme will now in due course receive the Royal assent.

Chatham.—At the meeting of the Chatham Town Council last week, a letter was read from the electric light company, in answer to the letter of the Corporation, asking if the company would sell their undertaking and upon what terms. The company stated they would give the Corporation an opportunity of inspecting the station and plant. We give a description in another note.

Inductor Dynamo.—Messrs. Pyke, Harris, and Co., Limited, have secured the money for the conversion into a company, and are enlarging the works at New Tothill-street, Westminster. They have several inductor dynamos of their new type in hand, and are building a 400-light machine of the same class. They are also very busy with some interesting novelties in small transformers for experimental and vacuum tube work, which we shall describe shortly.

Swinburne and Co., Limited.—This Company has been registered by S. Morse, 4, Fenchurch-avenue, E.C., with a capital of £25,000 in £5 shares. Object: to carry on in all its respective branches the business of electrical and general engineers and contractors. The first directors are James Swinburne, H. E. S. Holt, B. R Beale (managing directors), W. Lethbridge, and H. Bostock. Qualification, 25 shares. Remuneration to be determined by the Company in general meeting.

Incandescent-Lamp Holders.—Attention should be directed by shippers and continental users to an announcement in our advertising columns of a large consignment of some thousands of incandescent-lamp holders, which have been thrown on the market in consequence of recent litigation in America. Messrs. Henry F. Shippey and Co. have had an eye for business in securing these holders, for which there are many markets abroad, and for maritime purposes, where they can be advantageously used.

Craig House, Edinburgh.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, have secured the contract for the electric lighting of Craig House, Edinburgh. Craig House is a private lunatic asylum; in fact, one of the largest, if not the largest, in Scotland or in England. The installation will consist of two Lancashire boilers, 25ft. long by 7ft. 6in. diameter, four horizontal compound engines, each capable of giving 60 h.p., four Tyne compound-wound dynamos, each capable of running 400 16-c.p. lamps, and between 1,300 and 1,400 incandescent lamps and fittings.

Horse Traction.—It was stated at the last meeting of the Leeds Tramway Company on Friday last, that at the present time each horse cost 10s. 4½d. per week for hay and corn, and 3s. 8d. per horse per month for shoeing and veterinary attendance, therefore we may put the cost of each horse per week at about 11s. 4d. These are figures which may be somewhat interesting to the people engaged in promoting electric traction, but, of course, a good deal more information is required in order to get the actual net cost per horse per tram mile. When we have got this, a large number of other expenses will bring the total cost to a very much higher figure.

Hanley.—At the quarterly meeting of the Hanley Town Council last week the General Purposes Committee reported the receipt of a letter from the Local Government Board sanctioning the borrowing of £21,000 for electric lighting purposes. The Board at the same time stated that they approved of the use of so much of the lands of Hanley Park as was required for the site of the generating station. The sanction to the proposed loan was referred to the Loans Sub-Committee, with power to take steps to obtain the amount required; and the surveyor was instructed to advertise for tenders for the erection of the buildings required for the electric lighting station.

Extension in Leeds.—The Yorkshire House-to-House Electricity Company are already beginning to extend their mains. This step indicates that the demand is increasing. The mains to Headingley, recently constructed, terminate at a point near to the Oak Inn. Arrangements have been made with the highways department of the Corporation to carry the electric conductors from the point last mentioned a considerable distance up Otley-road. This extension is to be taken in hand as soon as the frost breaks. Numerous connections to the mains completed a few weeks ago have been made in various parts of the city, and many others are in hand.

Wisbech.—The chairman of the Wisbech Lighting Company, at the annual meeting last week, said there was before them the question of electric light, which was in a different position to what it was some years ago The cleverness of Mr. Chamberlain, with his careful mind, had stopped them with his clause for purchase after 20 years. Capital would not go in, and the late Government altered it to 40 years. Persons who were going in for electric light now had 40 years to develop it before it could be interfered with. The directors had not discussed or thought about it practically for Wisbech, as they had not thought it was a thing that at the present time could be entertained.

Birmingham Theatre.—The Queen's Theatre, Birmingham, is to be lighted by electricity, and the installation, when finished, will be one of the largest and most complete in the Midlands. It will consist of six 3,000-c.p. arc lamps. Two are to be fixed outside, two in the body of the theatre, and two on the stage (one each side). The footlights are 20 25-c.p. incandescent lamps. The batten or scene light will consist of three rows of 16 16-c.p. incandescent lamps, while about 70 16-c.p. lamps will be tastefully distributed throughout the building. In the main entrance will be fixed a 10-light electrolier in hammered iron in relief, and electroliers will be fixed in the refreshment-rooms. The work has been entrusted to T. L. Hemming and Co

Accrington.—A Local Government enquiry was held at Accrington on Wednesday regarding the application of the Corporation to borrow £10,000, amongst other sums, for the purposes of electric lighting. It was stated that the area proposed to be lighted included the whole borough, but only certain streets in the centre of the town were within the compulsory area. The Corporation had secured a site for a station in St. James-street. The Town Clerk added that the Accrington Gas Company charged at a dear rate for gas supplied, although they were right in the heart of the Lancashire coalfield. They were now paying 3s. 6d. per 1,000 cubic feet, subject to a small discount. The Corporation and the consumers generally thought the price too high, and that they ought to have the electric light. It was intended at first to light the public buildings and the streets about the Market Hall.

Coast Communication and the Coastguard Service.—The following "general memorandum," bearing the signature of Admiral Robert O'B. FitzRoy, admiral-superintendent of Naval Reserves, has been issued: "The district captains are informed that the Postmaster-General having requested that at stations which are connected by telephone or telegraph with postal telegraph offices (in the scheme of coast communication), the coastguard may transact telegraph business for the public, the Lords Commissioners of the Admiralty have informed him that they have no objection to private arrangements being made, if practicable, between his department and the families of coastguardsmen to transact telegraph business, on the distinct understanding that all correspondence on the subject shall take place independently of their lordships or the Admiral-Superintendent of Naval Reserves, and the coastguardsmen are not in any way diverted from their duties for the purpose of transmitting such messages or carrying them to their destination. The coastguard themselves are not to undertake the work."

Electric Lighting in the North.—We are informed that Messrs. Ernest Scott and Mountain are busier than they have ever been in their electrical department. Amongst important contracts in hand at the present time may be mentioned the lighting of the Co-operative Wholesale Societies' premises at Waterloo-street, Newcastle—this installation consisting of three Crossley gas engines of 25 nominal horse-power, and three 400-light dynamos, and about 12,00 16-c.p. lamps. Also the lighting of Mr. John Dickenson's engine works at Sunderland; the plant in this installation consisting of two 26-unit Tyne compound-wound dynamos, and 39 arc lamps of 2,000 c.p. and 3,000 c p., with about 120 incandescent lamps. They have also in hand the lighting of Barnby Manor, Newark, the residence of Mr Frederick Platt, and a large mansion in course of erection at Kirkby Lonsdale for Dr. T. Paget Tomlinson, and the firm are now building three large sets of combined engines and dynamos, each of 400 amperes output, for cruisers building by Messrs. Sir W. G. Armstrong, Mitchell, and Co. Amongst mill installations may also be mentioned the lighting of Messrs. Chadwick Bros. and Co.'s new spinning-mills at Bolton, and their spinning-mills at Riga, Russia.

St. Helens.—The borough surveyor of St. Helens has prepared a lengthy report on the cost of the lighting of the Town Hall of that borough by electricity during the three months ended December 31 last. The total run of the lamps was equivalent to 99,239 actual lamp-hours; and this is equal to 5,837 units of electricity used. The cost of generating was £84. 9s. 7d., or equal to gas at 2s. 11d. per 1,000 cubic feet. Other moneys, amounting to £10. 7s., have been spent upon the electric light since they commenced running in August last. The surveyor remarks that the cost of 3·47d. per unit is very reasonable for small installations; but he points out that the electric light has cost £47. 14s. 9d. more than gas did during the corresponding quarter of the previous year. The report was recently laid before a meeting of the Town Hall Committee. Mr. Burchall asked how it was that the cost of electricity exceeded the original estimate; they were told, when they adopted the electric light, it would only be the same price as gas. The surveyor replied that they had more lights in use than was originally anticipated. Mr. Johnson thought the assembly hall was no better lighted now than when gas was used; and he contended that the result was less satisfactory than was expected. Mr. Burchall remarked that they were led to believe that they would have a much better light than with gas at the same price. The town clerk thought the light was improved, and Alderman Bishop concurred.

Blackburn.—At the Blackburn Town Hall on Tuesday a Local Government enquiry was held by Mr. Rienzi Walton, M.I.C.E., one of the inspectors, regarding the application of the Corporation for sanction to borrow £50,000 for electric lighting purposes. In answer to the inspector, the Town Clerk said the population of the borough was now estimated at 126,000, and the rateable value over £428,134 Referring to the proposed scheme, the Town Clerk said it included all the principal streets in the town, all of which were within easy distance of the central station. Mr. T. Barton, consulting electrical engineer to the Corporation, then explained the plans for which he was responsible. The system, he said, was a low-tension, direct current, or secondary cells or accumulators acting as regulators. He calculated the cost of the light per unit at 4·75d., against which the selling price in London and Liverpool was 7d A Mr. Wolstenholme, who was present, asked if the Corporation would be able to supply the light as cheaply as gas. The Inspector: That is a very difficult question to answer. Mr. Barton said 7d. per unit was equal to 5s. 10d per 1,000ft. of gas That was the estimated cost, but it might be reduced to 6d. He wished to say, however, that shopkeepers and others in reckoning the cost of light must take into consideration the many decided advantages it had over gas. Mr. Wolstenholme questioned the wisdom of spending £50,000 on the scheme. The enquiry then closed.

Cardiff Town Council.—A meeting of the Lighting Committee of the Cardiff Town Council was held on Monday, under the presidency of Councillor J. Munn. There were also present Alderman Fulton, Councillors J M Gerhold, J. Evans, J. Jenkins, T. Andrews J. Herbert Cory, and M Morgan, Mr. F. M. Greenhill (deputy borough engineer), Mr. W. H Massey (electrical engineer), and Mr. T. Hughes (borough analyst). The town clerk reported that the mayor, Alderman Jacobs, and the borough engineer had been detained in London in consequence of an appointment with the Local Government Board upon matters connected with the question of electric lighting. Mr. Jenkins drew attention to the inferior illuminating power of the gas supplied in the public lamps in Grangetown. He suggested the fixing of a testing apparatus in that part of the town. It was decided that the matter be referred to the borough engineer and the public analyst for them to report upon. Mr. Jenkins complained of the lighting of North Clive-street, Grangetown, and moved the appointment of a sub-committee. After discussion, it was resolved that the gas company be written to on the subject. On Tuesday the Mayor of Cardiff (Mr. W. E. Vaughan), Alderman Jacombs, and the borough engineer (Mr. Harpur) waited upon the Local Government Board in London in reference to holding an enquiry to borrow money to carry out the scheme of electric lighting in Cardiff, and received the promise of an intimation, to be given on Monday next, as to when a commissioner would be likely to come down to hold an enquiry.

Inauguration at Dundee.—On Monday the electric light was turned on for the first time in Dundee. When first started, there was an indication that something was wrong, and the engineers at once made an investigation as to where the defect was After a careful examination of the mains it was found that in the connections made last week two of the wires had crossed each other at the foot of Commercial-street. When the wires had been rectified the current was again turned on, and the new light appeared in the *Dundee Advertiser* Office, the Royal Exchange, Merchants' Shelter, and other places, about 10 o'clock. For a short time the light was rather unsteady, mainly on account of the machinery and fittings being new. After a time, however, the lamps burned brilliantly and very steadily, and much satisfaction was expressed by a number of gentlemen who visited the various places mentioned as to the success of the experiment. In the newspaper office it was observable that the publishing office was brilliantly lighted, and showed to much greater advantage than under gaslight. The literary departments were much better illuminated than by gas The day and night service at the station will not be commenced for several days. The service for this week will cease after eleven o'clock, as the switch to the batteries which are to do the night work is not yet completed. The Gas Commissioners, at the outset of their operations, were advised that royalties were claimed on the three-wire system which they ultimately adopted, and they have paid a lump sum, which covers interest and sinking fund. This sum represents an annual cost to them of £10 per annum for a number of years.

Lambeth.—The Lambeth Vestry on Thursday last week, at the instance of Mr. Henry Dann, the chairman of the Electric Lighting Committee, consented to take the initial steps for the introduction of electric light. In June last the Vestry empowered the committee to seek professional advice, and upon that they consulted Mr. W. H. Preece, F.R.S., who submitted a preliminary report to the committee. After referring to the great advantages of electric lighting in making the streets safer from accident, and to the application of electricity to motive power for numbers of small industries, Mr. Preece points out that the inhabitants of the residential parts of West Norwood, Tulse Hill, Herne Hill, Stockwell, Brixton, and Kennington, many of whom are already educated to the use of electric light in the City, will probably be the first to demand it in Lambeth. In a few years, he thinks, one-third of the present 270,000 gas-burners in the parish would be replaced by electric lamps, and the revenue from these would be £40,500. The total capital required to cover the district would be £300,000, but a start sufficient to allow of 40,000 lamps being laid down would not require more than £75,000, and of this about £30,000 would have to be spent the first year, and £15,000 a year for three years more. The committee reports in favour of the borrowing of £75,000, and the taking of immediate steps to carry out a scheme on the lines laid down by Mr. Preece. The committee recommended that they should be authorised to negotiate for a site f the central station, and asked the Vestry to obtain power to b

£75,000 for the purpose of electric lighting. Mr. Dann moved the adoption of the report. Mr. White moved the further consideration of the matter be adjourned three months. The amendment was defeated, and the resolution to adopt electric light was carried by 46 to 30 votes.

Southampton.—At the Southampton Town Council meeting last week, the Free Libraries Committee reported that, having considered the question of the desirability of lighting the new public library by electricity, on the basis of a report prepared by Mr. J. G. W. Aldridge, they unanimously resolved that the electric light be adopted, and the Town Council be asked to make an application to borrow the sum of £400 for this work for a period of 20 years. Mr. Le Feuvre moved the adoption of the report, and stated that the total number of lights proposed to be placed in the building was 63--viz.: 15 of 8 c p., 43 of 16 c.p., and five of 32 c.p. The estimate provided for a newest-pattern gas-engine of 8 h.p., with a guaranteed consumption of gas at 193ft. per hour, at a cost of £160. The dynamo, fittings, controlling switchboard, etc., were put at £165, and the whole amount £412. With regard to the relative cost of gas and electricity, Mr. Le Feuvre gave figures to show that the former would be £93. 12s. per annum, against £81 for electricity. There were advantages from the use of electricity in regard to the preservation of the decorations and the binding of the books. Generally, the committee had satisfied themselves, not only as to the amount of the annual expense, but with regard to the abolition of the oppressive atmosphere associated with gas, that it would be very desirable indeed for the light required to be supplied by electricity. Alderman Bone seconded the adoption of the report. In reply to Mr. Hardiman, it was stated that the cost of redemption and interest was included in the calculation of comparative expenditure. Alderman Gilbert did not agree as to the excessive damage to books by gas, except as regarded those on top shelves. Alderman Lankester thought the estimate was over-sanguine, but if it was true, it was hard to pay 8d., 9d., and 10d. for electricity when the library could be supplied at 3½d The report was then adopted.

Bournemouth.—At the meeting of the Bournemouth Town Council last week, the Lighting Committee reported that they had considered a tender from Messrs. Goddard, Massey, Warner, and Co. for the additional work mentioned in the report of the committee, and recommended that only a certain portion of the added work be carried out. The committee reported that a sum of £160 would be saved if the Corporation workmen laid the principal pipes to receive the mains, which they recommended should be done. In reply to Councillor Beckett, the Surveyor said the original estimate for the electric lighting of the pleasure-gardens and pier was about £3,000, and they had sanction to borrow £4,000. They would not be overstepping the amount by adopting the recommendations of the committee. Councillor Beckett suggested that the Council were going on in this matter as they did with the sea-water scheme. The Mayor said the matter had been thoroughly considered. Councillor Jenkins said he would like to know exactly the amount of money which had been voted by the Council up to the present time in this electric light business, and the amount which was to be added? Councillor Moore said the Council had the amount before them in the report. The Lighting Committee did not agree with the report of the expert who had been employed, but they were dealing now with an exhaustive and well-considered report of their own surveyor. Councillor Beckett asked the surveyor whether he had enough engine power to pump the sea-water as well as to light the gardens and pier? Councillor Webber thought they would not want both at the same time. Councillor Moore said he would find all the information he desired in the surveyor's report. The Mayor said the electric light scheme as far as they had gone was estimated to cost about £3,600. In answer to Councillor Trevanion, the Surveyor stated there would be sufficient engine power to light the proposed pavilion as well as the pier and gardens for ordinary purposes. The recommendations of the committee were adopted.

Glasgow Town Council.—We give elsewhere an account of the starting of Glasgow electric lighting. At the Glasgow Town Council on Monday the subject was brought up on discussion of the minutes. Mr. Neilson drew attention to a paragraph to the effect that the inspector of lighting having handed in offers for material required in his department for the ensuing year, they were remitted to a sub-committee. He did not think that they should enter into any further contracts for material for the electric lighting of the city. Any gentleman who had visited the Continent and had seen the way most of the small towns, even in the North of Italy, were lighted, and leaving Paris out of account, would say that on Saturday night Glasgow made a poor appearance. It was to him a source of very great disappointment to hear the dissatisfaction after the lamps were lighted in the streets. The committee would tell them this was the latest mode of lighting; but if it was the latest, it was the worst ever tried. The lamps had been used in Ludgate-hill and in the City of London, but if the deputation had visited the northern districts of London, such as St. Pancras, they would have seen a different result from what they saw in the city. The contracts for the supply of material should be confined to the gas department until there had been further experiments with the electric lighting of the city. The Chairman said that Mr. Neilson had been rather out of order in bringing up the matter at all. Mr. Gray said that nothing was definitely settled in connection with any future contract. With regard to the animadversion on the electric light on Saturday evening, they had laboured under the disadvantage that the *inauguration had taken place* in the gloaming. Later on in *the evening, however, and again on Sunday* night he was in Sauchiehall-street, and really the appearance was magnificent. Mr. Neilson was altogether wrong in decrying what had been done. He was sure that the citizens generally took a different view to Mr. Neilson. The committee had had the opportunity of seeing what had been done in London, and he thought the Corporation of Glasgow had no reason to be ashamed if any comparison were drawn between the appearance of the streets there and Sauchiehall and Renfield streets. Of course, the committee had not been to the North of Italy; but perhaps they would be sent there too. Mr. Martin asked if lamps similar to those which had already been erected were to be used in the lighting of the other streets of the city. In the morning he had observed two men with a long ladder trimming the carbons of the lamps opposite the municipal buildings. On the Continent, in Berlin and Hamburg, this was not necessary, a single man standing on the street being able to lower the lamp and replace the carbons which had been consumed. He wished to know if the committee would try and introduce all the latest arrangements before adopting any plan in particular. Mr. Gray stated that the committee would be glad of any suggestions from Mr. Martin or anyone else when the matter came up again. The subject then dropped. Mr. Henry Mavor has written, in reply to the above strictures, to ask the public to wait a few days until the whole installation is going, when Glasgow will be second to none in street lighting.

Chatham.—The Corporation of Chatham are seriously thinking of negotiating for taking over the electric light station in that town, owned by the Chatham Electric Light Company, and a description of the enterprise may be of interest at this moment. Mr. Jasper is the chairman of directors, Mr. Hurrell is the managing director and engineer, and Mr. Powell is resident engineer. The local company has displayed a large amount of enterprise. First situated at Victualling Office-yard, the company were compelled to move their station, as this site was required by the South-Eastern Railway. The works—now in Church-street—are of considerable dimensions, and are almost in complete working order. A large coal-store at the back will hold 500 tons. The total amount now used averages between 10 and 12 tons a week. The boiler-house contains two large Babcock and Wilcox water-tube boilers, working at 120lb. pressure, and a third and larger boiler is now in place, and will shortly be ready for use. The water supply is obtained by two Worthington pumps from a deep well on the premises; from another well the water for condensing is obtained. The pressure from the town mains is also utilisable. The generator plant, at present fixed and working, consists of a fine Robey compound-condensing engine of 250 h.p., which was on view at the Glasgow Exhibition. It is fitted with Robey's patent trip gear for quick cut-off of steam, and runs at 86 revolutions. The engine drives a Ferranti alternator, which supplies a current of 50 amperes at 2,400 volts, representing 2,000 lamps of 16 c.p. In another part of the machine-room is a similar Ferranti dynamo, formerly used at the Rochester station, now being overhauled. In addition, there is in readiness for erection a new Mordey alternator, supplied by the Brush Electric Lighting Company, capable of supplying 800 16-c.p. lamps. This dynamo will be used in the earlier part of the evenings, or on Sundays and Wednesdays, when, owing to the shops being closed, their demand for the light is less. It will be driven by a Marshall high-pressure condensing engine of 100 i.h.p. A low-pressure cylinder will be added as the company's business increases, and the engines will then be of 200 i.h.p. A second Mordey alternator is on its way from the makers, double the size of the one just mentioned, and thus capable of producing sufficient light for 1,600 lights of 16 c.p. The motive power for this will also be obtained from a Marshall compound-condensing engine of 200 i.h.p. This practically completes the plant so far as the boilers, engines, and dynamos are concerned. This machinery, the whole of which will soon be ready for use, will enable the company to have at command an earning capacity of upwards of £6,000 per annum, and thus to more than triple its income at very little advance upon its present working expenses. The underground mains recently laid throughout the district are on the Brooks oil insulation system, supplied by Messrs. Johnson and Phillips, of Charlton. This is the first application of the Brooks system on a large scale in England to electric lighting. Distribution will be carried out on the sub-station system as with the City of London. Two independent sets of high-tension mains will be used with a pressure of 2,400 volts. The current will be transformed down by transformers placed in pits in the streets, at various points of the route. This plan will entirely obviate the necessity of putting transformers or taking high-pressure wires into houses. Each transformer will be fitted with a small low-pressure network, and from this the house-connection will be made. To give their customers the benefit of direct-current arc lights, the company have laid down special arc-light mains from their central station as far as Rochester Bridge, the current through which is supplied by the special arc-light plant of the Brush Electrical Engineering Company, Limited. The capacity of the station is estimated at 3,400 35-watt lamps. When everything is in complete working order the maximum expected to be obtained with the present plant will be about 7,000 35-watt lamps. The company is supplying at the present time current for 1,600 60-watt lamps. The maximum high-pressure current is 42 amperes. The price charged is very moderate—5d. per Board of Trade unit, which works out at ⅓d. per 16-c.p. lamp hour. With regard to fuel consumption the large engine has up to the present been running with a consumption of coal varying from 4lb. to 20lb., but as soon as the whole additional machinery is started, this will be worked effectively at its most economical load, the consumption then being only from 2½lb. to 4lb. per horse-power. The meters used are Shallenberger's, which have obtained the sanction of the Board of Trade. Lord Kelvin's electrostatic voltmeter is used in the station. Each of the sub-station transformers on the street mains are equal to 25 h.p. The Chatham section of the underground mains is now complete, and will in a few days be fully connected. The connection has already been made over a portion of the mains through which the light is being supplied with highly gratifying results. Everything is being carried out in a careful and thoroughly practical manner, and Chatham will certainly possess a good example of alternate-current central-station distribution.

Bradford Electricity Accounts.—At the meeting of the Bradford Town Council last week, Alderman F. Priestman (chairman of the committee) moved the adoption of the minutes of the Gas and Electricity Supply Committee. He said he had before him the balance-sheets of the gas and electricity departments, and thought that probably the Council would like to know what the results of the working of the departments had been. As to the gas department, there had been a considerable reduction in the receipts for residuals during the half-year, by comparison with the corresponding half of 1891, amounting altogether to £800 for coke, for tar £2,200, for spent oxide £600, and for sulphate of ammonia £500. Fortunately, there had been a considerable increase in the consumption of gas during the half-year, the total receipts amounting to £73,342. On the expenditure side the committee had paid for coal £700 less than in the corresponding half of the preceding year, and that was not the only benefit that they had derived. They had carbonised 500 tons more in the half-year, and yet there was a reduction of £700 in the wages of carbonising, which was largely accounted for by the employment of machinery at Birkshall Works in the place of hand labour. The other items of expenditure were pretty much the same as they were in the corresponding half of 1891. The committee had paid through the sinking fund £4,198, and for interest on loans £9,232. Taking all these figures into account, there was a profit on the gas department for the half-year's working of £2,274, as against a loss in the corresponding half-year of £868. This profit was made after including in the expenditure about £700 spent on the repair of the damage done by the recent explosion at the Valley-road Works. The quantity of coal carbonised had been 77,098 tons, and gas had been made to the extent of 799,250,000 cubic feet, this being 10,366 cubic feet of gas per ton of coal, an increase of 320 cubic feet per ton upon the figures for the corresponding half of 1891. This increase was to be attributed mainly to careful management. The quantity of tar made during the half-year was 4,746 tons, and the quantity of liquor was 10,241 tons. The number of ordinary public lamps in the borough was now 5,970, as against 5,874 in the period with which comparison was being made, and there were now 760 Bray's lamps in the streets The electricity accounts showed that the committee had sold electricity of the value of £4,548. 19s. 4d., which was somewhat over £1,000 more than was sold in the corresponding half. The other items of the receipts were practically similar in the two half-years. Coming to the expenditure side, he found that the coal had cost very little more than in the corresponding six months; that coke, of which there had been none in the corresponding half, had cost £48; and that repairs of tools and implements had cost £68, as against £17; repairs of works and plant £143, as against £21; and repairs of machinery £189, as against £11. It would be seen, therefore, that the works were being kept in efficient condition out of revenue. There was an item of £391 for trenching in Kirkgate and other parts of the town, and they had paid through the sinking fund £577, as against £398, and for interest on loans £719, as against £545. The result of the half-year's working of the electricity department, after accounting for all these matters, had been a profit of £1,089. Taking the general balance-sheet of the electricity department, they had spent £48,568. 12s. 11d. on capital account. That figure included everything which had been spent on the buildings and plant. The general balance-sheet showed that they owed to the bank £4,380, that there was owing on account of loans £47,291, and that they had paid through the sinking fund from the commencement £3,198, which had all been paid for out of revenue. Taking the history of the working of the department since commencement, it would be found that in 1889 there was a loss, including payments on account of sinking fund and interest, of £1,079; in the half-year to June 30, 1890, there was a loss of £732; in the December half a loss of £315; and in the first half of 1891 a loss of £30. For the second half of 1891 there was a profit of £970, for the first half of 1892 there was a profit of £387, and last half-year there was a profit of £1,089. So that from the commencement of the work of the department they had extinguished the whole of the loss resulting in the earlier stages besides paying interest for sinking fund, and there was a net profit on the undertaking up to date of £289. 15s. 7d. Perhaps it would be of interest to the Council also to know whether they were working as economically as other people were. Therefore, for the purpose of challenging comparison, he would state that the numbers of units sold in the last four half-years were 85,103 and 154,258 in the first and second halves of 1891, and 141,622 and 224,232 in the first and second halves of last year. The number of pounds of coal used per unit of electricity in the same four periods were as follows: 16lb. and 12·58lb. for 1891 and 12·5lb. and 10·1lb for 1892. So far as they could tell, the lowest consumption on record at any central station had been 8lb. per unit, and this was obtained from Welsh coal at 27s. per ton, whereas the cost of the coal used at Bradford was about 8s. 6d. The cost of coal per unit for the four periods referred to were respectively ·67d., ·53d., ·56d., and ·42d. The number of customers for electricity was largely increasing. During the last half-year 41 new customers had been obtained, and there were still many applicants. Mr. Joseph Kay seconded the adoption. Mr. L. Walker asked if in his next half-yearly statement Alderman Priestman would include the electricity used by the Bradford Corporation in the Town Hall, free library, and other public buildings. He asserted that the cost of lighting the Town Hall clock alone amounted to £800 a year, and that, owing to the pressure of the chairman of the Gas Committee, the Corporation was now using a third of the electricity produced, so that Alderman Priestman might be able to make out that it was paying. Alderman Priestman reminded Mr. L. Walker that the cost of lighting the markets and the Town Hall did not enter into last half-year's electricity balance-sheet at all, as these were new works, and at the free library the electric light had been used in a very economical way. The minutes were adopted.

Water Power for Cardiff.—The following combined article and interview with Mr. Sydney F. Walker appears in the *South Wales Daily News* of the 23rd ult. "'The load, or work to be performed by an electric lighting company,' said Mr. Walker, when I had a conversation with him on Tuesday at the Cardiff Electrical Works, 'is best shown by a curve. Now, it is a curious fact that in the experience of these companies it is found that during only two hours of the 24, generally between 5 and 7 o'clock in the evening, is the full load required. The preparation of a diagram works out in this shape,' and Mr. Walker sketched an imaginary supply sheet which, for want of a better simile, I will liken to the 'barometrical indications' chart published in some newspapers, and familliar to the public generally. The downward columns are 24 in number, and the cross columns range from zero to the highest potential of the machines at the command of the lighting company. 'You see,' continued my informant, 'the pressure gradually rises until about 5 p m., when it suddenly shoots up to a high point, and this is maintained until before 7 p.m., when it begins to fall, and then drops with great rapidity. In this fact you have my reason for advocating the use of a low-tension continuous-current supply as opposed to the alternating-current method, as, so far as my experience goes, accumulators cannot be used in connection with the latter. With the low-tension continuous current you are enabled to store up the surplus power of your machinery during the hours of non-activity, and during the two hours of increased use you can thus have a store of electrical energy to fall back upon. With the alternating current this is impossible. Your machinery must be equal to the task of fully meeting the highest calls made upon it, else it fails at the precise moment when it is most required. An alternating current is a high-tension current conducted by cables to different points of destination, where it is broken up by means of transformers into smaller supplies for the use of private consumers. But, with the exception of the Newcastle Company, the companies that have shown the best financial results are those which use low-tension continuous currents, and charge accumulators during the day. It is obvious that there is far less strain upon the electrical machinery by this greater distribution of work.'

"These considerations, after all, are matters for experts to determine; so, in electrical phrase, I switched Mr. Walker into another wire by asking him what could be done to utilise the waterworks system of Cardiff in connection with the electric lighting of the town. His statement, in general terms, took the following form:

"'I must first safeguard myself by saying that I am not quite certain as to my data, but if these are not strictly accurate, they are sufficiently so for all practical purposes. The fall from the Taff Fawr to Llanishen is, I take it, roughly speaking, 900ft. There are two balancing reservoirs *en route*, one at Quaker's Yard, and one at Rheubina, thus splitting up the fall into three stages of 300ft. each. The daily consumption of Cardiff may be taken as 4,000,000 gallons. Well, I would establish turbines at Llanishen and Rheubina, and a third at some point nearer Cardiff, where the water would still have sufficient power left to serve the needs of the town. This latter break is, of course, entirely a matter for the waterworks engineer to decide upon, and, failing its utility, the higher station at Quaker's Yard might be called into requisition. The turbines at each point would transmit the water pressure to dynamos, and thence the supply of electric energy thus obtained would be conveyed by cables to the Cardiff central station, which is, I believe, to be erected somewhere on Leckwith Common. Now, if the people of Cardiff use 4,000,000 gallons daily, spread over, say, 16 hours each day, from one station alone, with half the fall, we would obtain, at the very lowest computation, 100 h.p. per hour, or 1,600 h.p. daily, available for the public service. The yield is really much higher, nearly twice as much, but there is a great loss through friction and the charging of secondary batterier, or accumulators, from the dynamos. However, we have finally 1,600 h.p. at our disposal, and estimating that one-fourth of the supply will be sufficient for the low periods of the daily curve, there is 1,200 h p. left to deal with the time of active demand between 5 p.m. and 7 p.m. The curve I have imagined, bear in mind, applies to the winter months. In summer, of course, the demand for electrical energy is greatly diminished. If you treble the stations you have, at the lowest estimate, sufficient electric energy for 36,000 lamps of 10 c.p. This is the ordinary power, and the consumption is 20 supply watts per annum.' (The Board of Trade definition of a watt-hour is 1,000 watts, and I hope my readers have not forgotten since yesterday what a 'watt' is.)

"We then discussed the question as to the number of lamps probably required for Cardiff, and, after some consideration, the basis of which need not be given, arrived at the conclusion that, if generally taken up by the public, about 120,000 would be the figure. Thus Mr. Walker's scheme would give about one-third of the motive power required for private lighting alone, but it must be remembered that, in view of the stat [illegible] it is quite on the *tapis* that a f [illegible] would be forthcoming from [illegible] if they were fully called into action, than the quantity estimated by Mr. Walker. However, private lighting is a very difficult matter to decide upon. Many property owners would not take it up, and there would be an enormous upheaval if every house in Cardiff substituted electric light for gas. So we changed our ground to the more defined project of public or street illumination, and here Mr. Walker had a strong case.

"'During 16 hours of the day,' he said, '300 lamps could be maintained, and these would light our main thoroughfares far better than they are lit at present. This brings me back to the question of high-tension currents. The arc lamp, which is to be sustained by that means, is a much more expensive lamp to keep up than the incandescent. At the present time it costs from 25 to 50 per cent. more than an incandescent which uses the same amount of energy. The arc lamp is not being improved, whereas the other is improving daily, and, with the expiration of the patent very shortly, we may expect much greater developments in its powers. It is only a question of time for the incandescent lamps to displace the arc lamp entirely. Therefore I hold it would not be wise to lay down plant now for the use of the arc lamp, when this is likely to be soon quite superseded, and the arc plant is absolutely useless for any other installation. At the Dowlais Ironworks they had four arc lamps lighting some coke-ovens, and another machine alongside was running 50 incandescent lamps. Now they use one machine for lighting the whole works, and the arc lamps have been replaced by the others. If you take the difference in working cost between the 60 arc lamps proposed to be erected and 60 300-c.p. incandescent lamps, I estimate the saving in interest on plant to be something like £1,000 a year. Moreover, it is proposed to light the streets by arc lamps until midnight only, and then fall back upon gas. Now, the arc lamp is either in or out; there is no medium. But the incandescent lamp may be reduced in lighting power, and thus the strain upon your machinery is lessened.'

"'By the application of water power as opposed to steam what saving to the town, in your opinion, would result?' 'Something like £3,000 per annum. A supply unit costs, in round figures, 1d. for a pound of coal. Three hundred street lamps consuming 2,400 units each per annum would mean a saving of 720,000d., or £3,000, yearly, because, taking the cost of your plant in each case as equal, you save the fuel.'

"Such decided statements as these," continues the article, "challenge considerable attention. It is evident that after the water power *v.* steam combat is settled there remains the fight of the lamps. Mr. W. H. Massey has already expressed his opinion that the arc lamp is the better of the two, and Mr. Harpur, the borough engineer, is said to incline to the same view. Certainly in most of the continental installations the alternating current, with arc lights, seemed to be the most popular; but it must not, therefore, be too readily assumed that Mr. Walker is wrong. He made a most important point with reference to the approaching expiration of the patent in the incandescent lamp, and experience in other directions—the sewing machine is a familiar example—shows the resultant advantage when a useful invention is thrown into the open market. Unless, therefore, it can be demonstrated that the arc lamp is so greatly superior to the incandescent as to warrant a large expenditure in laying down special plant for its accommodation, it is obvious that we should not be rashly committed to a policy which may cost much to alter in the future. The experience gained by the Dowlais Company, too, is of some weight, and so far, my enquiry results in the definite opinion that every side of the question should be minutely examined before the Corporation takes the irrevocable step, and commits itself to the one lamp or the other. As for the source of supply of electric energy, there is still more reason for investigation into the possibilities of utilising the water power at our command."

Manchester.—The works so long in contemplation for the lighting of the central district of Manchester by electricity are now within measurable distance of completion. It is hoped, says the *Manchester Guardian*, that they will be in operation by the month of June at latest. One of the first places to be lighted will probably be the Town Hall, where an installation of about 2,500 lights is being rapidly pushed forward, and other public buildings will afterwards be dealt with in such order as may be agreed upon. For the present it is not intended to light any of the streets with the electric light. The bulk of the demand is expected to come from the public buildings and from the shops, offices, warehouses, and other places of business within the area to which the installation extends. As is generally known, the work of installing the light is being done by the Corporation under powers conferred by a provisional order obtained in 1890. After mature deliberation they adopted a scheme designed by Dr. John Hopkinson, and it is this scheme that is being carried out, at a cost which will probably reach over £100,000. The system adopted is the low-tension five-wire system, which gives a current of from 100 up to 400 volts. In America the high-pressure alternating machines are chiefly employed, and one advantage they possess is that of cheapness in the first instance. With these machines very small wires are used, and it is necessary on that account to apply all the more pressure, and the high pressure is not without its dangers, as is shown by the many fatal accidents to men employed on electrical works in America, and by a similar occurrence in London a few weeks ago. That this danger is fully recognised may be inferred from the circumstance that the Board of Trade do not permit high-pressure electricity to be sent into any consumer's premises. Even where it is sent out from the generating station and along the wires at high pressure they insist in their regulations that before it is turned into the consumer's premises it shall be transformed by suitable appliances into a low-pressure current. On the ground of safety and on other grounds, the thicker wires and larger appliances used for the low-pressure system have been laid down in Manchester. The old town yard in Dickinson-street, near the foot of Portland-street, is being utilised as the central station for generating the electric current. It is close to the area to be supplied, and this, combined with its proximity to the Manchester and Rochdale Canal—which runs along three of its sides—makes it one of the most suitable sites that could possibly have been obtained. Since the ground was taken possession of for its present purpose a wonderful change has taken place in its appearance. On the right, passing through the large gateway, still stands the old house—now used for offices by Mr. H. Wooler, the Corporation electrical engineer, Mr. John Taylor, the clerk of works, and other officials—but in every other respect the old yard appears to have undergone a transformation. Two of its chief feature now are a chimney over 200ft. high, and huge buildings in which the boilers, engines, dynamos, and other appliances will be housed. The buildings are now roofed in and nearly ready for occupation. The boiler-house is 77ft. long by 70ft. wide, and there is ground at command to double the dimensions if that should be rendered necessary by the demand for the electric light. From end to end the boiler-house is covered with a tank weighing altogether about 150 tons, and capable of holding 200,000 gallons of water, a supply which will no doubt be found large enough for some time to come. An electrical crane runs along the entire length of the building, and by this means the canal boats will be rapidly unloaded of their cargoes of coal. Between the water-tank and the floor of the engine-house adjoining there is an intermediate coal-stage with bunkers attached for mechanical stoking. The boilers, six in number, are now being put in their places. Each one measures 30ft. by 8ft. They are all of the Lancashire type, and are steel-plated. All their flues are discharged into a large main flue in rear of the boilers, and this large flue is connected with an economiser-house built between the boiler-house and the high chimney already mentioned. Before the exhaust heat finally escapes it is in this manner utilised to aid in the heating of a twofold range of 280 pipes used to feed the boilers with warm water. Pausing on the way from the boiler-house to the engine-house, an opportunity is given of looking up through the great chimney, with the somewhat remarkable result that at the top there is seen a bit of sky, and—still more incredible—there is a distinct suggestion of blue about the colour of it. The chimney from the inside of which this view was obtained measures 34ft. square at the base; it is 212ft. in height, and 11ft. 10in. in diameter at the top. The engine and dynamo house measures 206ft. in length, 80ft. in width, and 43ft. in height. It is lined with glazed bricks throughout, and the walls are ornamented with dado, frieze, etc. The building is divided into two bays, and has a double row of standards through which the steam conveyer pipes will run at one elevation. At another elevation there is an iron gangway, or platform, and there are next reached longitudinal girders on which a 10-ton crane will travel the whole length of each bay for facilitating the setting and hauling of the machinery. Underfoot, as overhead, the work appears to have been done in a very substantial manner. The foundations and beds for the engines and dynamos are of solid concrete, and they have been made 12ft. thick, in order to prevent the possibility of vibration and consequent annoyance to the tenants of the surrounding buildings. Bed-bolts have been fixed ready for securing the engines and dynamos, which have been already constructed and are under order for immediate delivery. There are to be four large vertical compound engines of 360 h.p. nominally, and six other engines of 90 nominal horse-power, and the dynamos, of the Edison-Hopkinson type, will correspond with the engines in number and power. Provision is made in the engine-house for a switchboard with all the most approved appliances for controlling the electrical plant and regulating the current according to requirements. There will also be attached to the works an electrical laboratory for the testing of meters and other work. The area of supply consists of a square which embraces the following streets and other main streets within and adjacent to them — viz.: Deansgate (from Peter-street to St. Mary's Gate), St. Mary's Gate, St. Ann-street, Market-street, Piccadilly, Portland-street, Mosley-street, York-street, Spring-gardens, King-street, Princess-street (from Portland street to Albert-square), John Dalton-street, Cross-street, Albert-square, South-street, Oxford-street (from Portland-street to Peter-street), and Peter-street. It will thus be seen that the square includes the very heart of the city. Beneath the streets there is at many points a fearful and wonderful interlacing of pipes for manifold purposes connected with the life of the city. With pipes and tubes for gas, water, telegraph, telephone, and pneumatic purposes in profusion, if not in confusion, it has sometimes almost passed the wit of Mr. Wooler and his staff to find a clear passage for the pipes or culverts containing the electric-light conductors. The corner of King-street and Cross-street, near the old Town Hall, presented a somewhat difficult problem, and amongst other points at which pipes were encountered in embarrassing numbers were the corner of Princess-street and Cooper-street and the junction of Cross-street with Market-street. These and other obstacles have been wrestled with and overcome, and now main conductors have been laid of sufficient strength to carry a current far in excess of what will supply 40,000 8-c.p. incandescent lamps, which represents the capacity of the plant that is now being installed. The wires by which the current is sent along under the streets are not wires at all, it may be explained, but bare copper strips clamped together to form a square inch section, and these are put on porcelain insulators and, wherever possible, lighted that night, and there were 108 to complete the system, but even that number was very far from being sufficient to light the city of Glasgow. He hoped to see the incandescent light in all houses, shops, and offices, and 200 or 300 lamps in all the principal streets of the city—even all the dark corners and by-streets lighted up with this new illuminant. In that way they might secure for Glasgow what had been arrived at in New York—a prodigious diminution of crime He did not mean that Glasgow was so bad as New York in that respect, but still there might be room for improvement. His Lordship said the citizens owed a debt of gratitude to the two committees, the Electric Lighting and the Watching and Lighting Committees, for the harmonious way in which they had acted. Fortunately, here there was no counter interest, as both gas and electric light were in the hands of the Town Council, and while wishing success to the Gas Trust of Glasgow, they could at the same time wish every success to the electric light. He begged to move a vote of thanks to Mr. Ure and Mr. Gray, the conveners of the two committees.

Mr. URE briefly acknowledged the compliment.

Mr. GRAY also thanked Lord Kelvin for the vote of thanks, and remarked that nowhere was there cheaper and better gas than in Glasgow. Since the gas trust passed into the hands of the Corporation the price of gas had come down from 4s. 7d. to 2s. 9d. per 1,000 cubic feet, and even with these large reductions there was a profit of some £1,500 a year. That sum the committee applied to the extra lighting of the streets, which were better lit now than they had ever been before. The amount of gas consumed in the street lamps was exactly double what it was seven years ago. He had to thank the Electric Lighting Committee for the liberal terms they had given the Watching and Lighting Committee. The Lord Provost said to the committee that if they went into this matter the Electric Lighting Committee would give them the light as near as possible at cost price; and the terms offered and accepted were £20 per lamp, as against £26 paid in London. If the scheme went on, as he hoped it would, they would be able to extend the electric lighting of the city with great advantage to the public. It might even be put into all the byways of the city, and while a help in the way Lord Kelvin had referred to, the light would be an attraction to the city of which they were all so proud.

PROVISIONAL PATENTS, 1893.

February 20.

3690. **A combined ammeter and voltmeter.** William Richard Morris, 293, Wheeler-street, Birmingham.

3729. **Improvements in the supply of electric current for electric railway, tramway, and other purposes.** Gisbert Kapp, 31, Parliament-street, Westminster, London.

3734. **Improvements in secondary battery plates or elements.** Arthur Hough and Octavius March, 14, New-inn, Strand, London.

3743. **Improvements in the preparation of carbon electrodes for electrolytic operations.** Edward Henry Liveing, 6, Bream's-buildings, Chancery-lane, London.

3744. **Improvements in the construction of carbon electrodes.** Edward Henry Liveing, 6, Bream's-buildings, Chancery-lane, London.

3747. **Improved process for the production of electrolytic copper.** Marcel Perreur-Lloyd, 53, Chancery-lane, London. (Complete specification.)

February 21.

3757. **Improvements in thermo-dynamic motors.** Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

3779. **A new or improved carbon-holder for arc lamps.** Webster Storr, 37, Chancery-lane, London.

3804. **Improvements in electro-photography.** Jasper Waring, 10, Russell-road, Albert-road, Peckham, London.

3817. **Improvements in armature cores.** Albert William Smith, 40, Chancery-lane, London.

3823. **Improvements in electromagnetic motors.** Paul Eugene Mourot, 46, Lincoln's-inn-fields, London.

3831. **Improvements in telephone exchange systems.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

3833. **Improvements in electric connections.** Edward William Lloyd, 24, Southampton-buildings, Chancery-lane, London.

February 22.

3883. **Improvements in and relating to the distribution of electrical energy.** William Lowrie, 117, Bishopsgate-street Within, London.

3953. **Improvements in the construction of field magnets for dynamo-electric machines.** Edward Thomas Hughes, 38, Chancery-lane, London. (Cornelius F. Daniels, United States.)

February 23.

3966. **Improvements in and relating to the distribution of electrical energy.** William Lowrie, 117, Bishopsgate-street Within, London.

3979. **Improvements in telegraphic receiving instruments.** Johannes Frydendahl Hoffgaard, 17, St. Ann's-square, Manchester.

3980. **Improvements in telegraphic receiving instruments.** Johannes Frydendahl Hoffgaard, 17, St. Ann's-square, Manchester.

4024. **Improvements in storage batteries or accumulators.** William Phillips Thompson, 6, Lord-street, Liverpool. (The firm of A. Vogel, Germany.)

4036. **An improved means of taking power from electromotors** Charles Riley Garrard and Thomas William Blumfield, 37, Chancery-lane, London.

4040. **Improvements in typewriting telegraph instruments.** Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

February 24.

4077. **Improvements in the construction of electrical measuring instruments.** Henry Capel Lofft Holden, The Royal Arsenal, Woolwich.

4086. **Improvements in and relating to electrical switches, partly applicable to other electrical appliances.** James Henry Ward and Meyer Hart Goldstone, 4, St. Ann's-square, Manchester.

4087. **Improvements in and relating to terminals for electrical purposes.** James Henry Ward and Meyer Hart Goldstone, 4, St. Ann's-square, Manchester.

4091. **Improvements in electrical measuring and other instruments** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 16, Red Lion-street, Clerkenwell, London.

4096. **Improvements in dynamo-electric generators, motors, and motor-generators.** Rankin Kennedy, 1, Clifton-villas, Camden-square, London.

4103. **Improvements in and relating to dynamo-electric machines.** William Lowrie, 117, Bishopsgate-street Within, London.

4106. **A process for maintaining positive plates of secondary voltaic batteries in good operative condition.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

4111. **Improvements in means or apparatus for establishing telegraphic communication with trains.** Frederick William Golby, 36, Chancery-lane, London. (Nicolas Jean Baptiste Etienne, France.)

4144. **An improvement in the electrodes of electric, galvanic, and other batteries.** Alfred William Armstrong, 20, High Holborn, London.

February 25.

4188. **Improvements in electric retouching of photographs, and in apparatus therefor.** Rankin Kennedy, 1, Clifton-villas, Camden-square, London.

SPECIFICATIONS PUBLISHED.

1880.

1704. **Electric lamps.** Haddan. (Bureau.) (Second edition.)

1882.

3576. **Distributing electricity.** Hopkinson. (Third edition.)

1890.

20612. **Electric lamps.** White. (Second edition.)

1891.

14234**. **Electric railways.** Cattori. (Amended.)

1892.

310. **Electric conductors.** Andrews.

4068. **Telephones.** Booth and Falconer.

4158. **Electric circuits.** Edmunds.

4258. **Dynamo-electric machinery.** Spence.

6405. **Secondary voltaic batteries.** Urquhart and Small.

16980. **Electrical accumulators, etc.** Robins.

18807. **Secondary batteries.** Andreoli.

23409. **Storage batteries.** Washburn.

23421. **Incandescent electric lamps.** Mills. (Hutchinson.)

23919. **Electrolytic apparatus.** Craney.

23967. **Electric arc lamps.** Lake. (Coerper.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	$2\frac{7}{16}$
City of London	—	12½
Electric Construction	10	2¾
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4⅛
London Electric Supply	5	¾
Metropolitan Electric Supply	—	6¾
National Telephone	5	$5\frac{5}{16}$
St. James'	—	8
Swan United	3½	$3\frac{5}{16}$
Westminster Electric	—	5⅞

NOTES.

Turbines.—At a students meeting of the Institution of Electrical Engineers, on Friday, the 17th inst., a paper will be read on "Turbines," by Mr. C. V. Drysdale.

Electric Furnace.—*Electricité* gives (March 2nd) some illustrations of M. Moissan's artificial diamonds, and also of the electric furnace employed in his interesting researches.

Technical Education.— A paper on "Technical Education, its Progress and Prospects," by Sir Philip Magnus, will be given before the Society of Arts next Wednesday at 8 p.m.

Electricity in Mines.—It is announced that a professorship of industrial electricity has been created for the French School of Mines. The usual courses at this school are open to the public.

Train-Signalling.—The *Railway Engineer* is giving a series of articles on train-signalling, electric and otherwise. Some bold diagrams of Tyers tablet system are given in the March number, with description.

Accumulator Traction in Berlin.—The Berlin Tramway Company has authorised experiments in electric traction by means of accumulators on one of its line. If the trials are satisfactory, it is thought the company will establish a new line worked by accumulator traction.

Indian-Ink Stand.—Draughtsmen are an important section of the electrical engineering industry, and they may thank us for mentioning a new inkstand for Indian ink invented by Mr. Maginnis. It is in two pieces, revolving one on the other at a slant. By turning the top on e round any desired angle of inclination can be obtained.

Hayti.—The French Submarine Cable Company are erecting the telegraph lines before connecting the seat of government to the important towns and districts of the Republic of Hayti. For some time a telephonic system has been established, largely subventioned by the Government, which is very progressive. The charge for telephone service is five dollars a month.

Ploughing by Machinery.—M. Y. Guédon, civil engineer, has an article in *Cosmos* on tillage by steam-engines in France. Messrs. Boulet et Cie. at the last exhibition in Paris exhibited machinery for winding gear for this purpose, and now that the waterfalls are being utilised for electrical distribution, it is not improbable that electrical energy will be applied in the same way.

Electric Traction at Brussels.—A pioneer company has been formed at Brussels to carry out a scheme for an underground electric railway to go the round of the city. Cars, with motors attached, to carry 40 persons each, are proposed, and the descent to the stations will be made by electric lifts. The construction of the line will be similar to that of the South London, and Mr. Greathead is the engineer to the enterprise.

Universal Telegraphic Hour.—Signor César Tondini de Quarenghi has long waged a single-handed fight for the establishment of a universal hour for telegraphic purposes over the world. In the *Journal Télégraphique* he has written a series of articles marshalling his facts and arguments with skill and insistance on this point. The initiative was taken in 1872 by the Turkish Government for a proposal to count the hours 1 to 24 for all telegraphic work from a fixed meridian. Signor Quarenghi seems to hope that Russia might accept, and if France threw in the weight of example, a universal time might, he thinks, be hoped for by the 1st of January, 1900. As electricity practically annihilates geographical time, there is much to be said for such a proposal.

Electrical Books.—There are one or two publishers who make a special department in electrical books. Among these are Messrs. Crosby Lockwood and Co., whose prospectus of this class of book has been sent to us. The "Standard Electrical Dictionary," by T. O'Conor Sloane, is one of the most imposing, consisting of 600 pages with 350 illustrations, containing 3,000 definitions. Some idea of the progress of electrical terminology during the last decade or two may be hereby gathered. Mr. J. W. Urquhart's books on "Dynamos," "Electric Light," "Ship Fitting," and "Electroplating," find ready sale. One of the most important and generally useful is Kempe's "Electrical Engineers' Pocket-book," now in a new edition. A catalogue of other scientific and technical books is issued free by the same firm.

Popular Electricity.—The *Glasgow Herald* is opportunely publishing some popular explanatory articles on "Electricity as an Illuminant," as a rule well written and accurate. One or two statements are, however, a little beside the truth. The article says "a workman whose hands were rough, dry, and horny, might handle with impunity wires carrying two or three thousand volts." We should not care to see the experiment tried. In explaining the three-wire system the writer seems to have mixed up the use of feeders with the use of the neutral wire. The three-wire system does not necessarily obviate fall of pressure along a length of main, nor is this its chief function, but rather to save copper for the same lighting capacity. The popular appreciation of explanatory articles is considerable, and many papers are giving occasional attention in this direction.

Electric Railway Traction.—Herr Bork, a German engineer of repute, has published his opinion that electric traction is likely to have a great future for railways. He calculates that to run trains at 30 to 50 miles an hour, electric motors would only require 60 per cent. of that required by steam locomotives. He shows the gain supposing a train of 60 tons at 50 miles an hour on a gradient of 0·5; the steam locomotive will require to develop 548 h.p., while electric traction would only need 280, or an economy of 51 per cent.: for 35 miles an hour the gain would be 69 per cent., or a mean of 60 per cent. at 45 miles. He gives the cost of traction per kilometre with steam as 0·521f., and with electricity 0·346f., a gain in cost of running of 66 per cent., and including considerations of depreciation, increase of number of trains and speed, he considers an eventual gain of 70 per cent. may be theoretically expected.

Germany.—Statistics show that Berlin is now lighted by 2,916 arc lamps, and 67,459 incandescent lamps. In addition to these there are 253 private installations, 170 of which are driven by steam, and 83 by gas. These private installations supply 3,287 arc lamps and 40,801 incandescent lamps. Recently it might have seemed to some of us that we were progressing somewhat satisfactorily in England, but our German friends seem to be taking to the electric light far more rapidly than we in England. In our last issue we referred to the designs which had been prepared for the lighting of Strasburg. It is proposed also to erect a plant at Bad Nauheim. At Upper Bavaria, central stations are provided at Bruck, Erding, Tölz, Neuötting, and Reichenhall. Water power stations are to be erected at Burghausen and Cham. The harbour of Magdeburg is being lighted by Messrs. Kummer and Co., of Dresden. Anyone who desires to obtain pretty full information as regards the lighting of Hanover should consult an article by Von F. Uppenborn in the *Elektrotechnische Zeitschrift* of March 3.

Municipal Engineers.—On Saturday last the first meeting of the year of the home district of the Association of Municipal Engineers and Surveyors was held in London. There were about 60 members present, and in the first place they met at Streatham-hill to examine the cable company's power station, after which the members drove to Fulham to view the river wall, in course of erection under the Fulham Vestry. The third visit was to the central station at St. Pancras, where the members were met by Prof. Robinson, who read a paper to them descriptive of the station. We have so often given details of the installation at this station—and quite recently we gave a balance-sheet of the working—that it is unnecessary to do more than call attention to the fact that so many engineers paid it a visit. Many of these engineers have stations in their own districts, and some are preparing information for their authorities on the subject of electric lighting. All seemed very much interested in the work which is being carried on by the St. Pancras Vestry.

Ruthenium.—The usefulness of electricity in chemical science was forcibly demonstrated at the Académie des Sciences on February 27, when M. Troost presented an ingot weighing 4½lb. of ruthenium, a metal only found in the minutest quantities associated with platinum. The mass shown to the Académie is probably greater than the whole of the rest of the specimens possessed by the world's chemical laboratories. It was prepared by M. Joly with the aid of the dynamos of the Paris electrical laboratory by heating the residues of the preparation of iridium. M. Troost announced that M. Joly hoped to prepare an ingot of 26lb. Anent this product, M. Bertrano related that the international metre was to be formed of an alloy of 10 per cent. iridium and 90 per cent. platinum. By a mistake made by one of the assistants, a certain quantity of ruthenium was put into the ingot from which the standard metres were made, and although it no ways changed the density and coefficient of expansion, the standards were rejected, causing a loss of some hundreds of thousands of francs. M. Troost exhibited, besides the large ingot of ruthenium, a small sample of melted ruthenium.

Electrolytic Production of Lead Oxide.—Hydrated oxide of lead, employed in chemical industry for several purposes, may be prepared electrolytically by the following process, described in the *Revue de Chimie Industrielle.* Electrodes of lead are immersed in a 10 per cent. solution of nitrate of soda, contained in a vessel furnished with porous diaphragm. Nitrate of lead is formed on one side, and caustic potash on the other. When the current has acted for a certain time, the liquids are poured into a second vessel provided with an agitator; the soda and nitrate of lead produce oxide of lead and nitrate of soda, which re-forms. This is passed to a filter press to collect the oxide of lead, and the liquid is poured into the vessel with porous partition for a fresh operation. The lead oxide is washed, dried, and ground. The operation may be rendered continuous by constantly feeding the two compartments of the first vessel with regenerated nitrate of soda; an equal volume of liquid will flow into the agitating vessel. This liquid is drawn off by a pump to the filter press, and the clear liquid is returned to the electrolyser. An ampere-hour produces 4·5 grammes of lead oxide.

Meteorological Problems.—A lecture will be given by Mr. Shelford Bidwell, F.R.S., before the Royal Meteorological Society, at 25, Great George-street, Westminster, on Wednesday, the 15th inst., at 7 p.m., on "Some Meteorological Problems," which will be illustrated by experiments. The following is the syllabus of what would seem to be a most interesting lecture: Probable sources of atmospheric electricity; experiments showing electrification produced by evaporation and by friction of dust; different forms assumed by the lightning flash and their probable causes; photograph of flashes and electric sparks; projection of Leyden jar discharge—its resemblance to lightning; phosphorescence of the air—illustration; duration of flash—experiment with revolving disc painted in sectors; the flicker of lightning and its explanation—illustration with a vacuum tube; efficiency of lightning conductors; Lodge's two forms of lightning discharge—illustrated; darkness of thunder clouds, and large rain drops of thunder showers; electrification of steam jet and water jet; dust in the air essential for condensation of water vapour; colour of the sky; Abney's experiment illustrating the formation of sunset colours.

Electricity at Manchester.—Mr. W. W. Haldane Gee, of the electrical engineering department of the Municipal Technical School, delivered a lecture on Tuesday in the Newton Heath Public Hall on "The Electric Light." Mr. Councillor Rothwell presided. Mr. Gee explained at length the development of electric lighting. The incandescent lamp, he considered, made a fairly ideal means of lighting, as it was not only powerful, but absolutely free from such noxious products as were thrown off by gas and other artificial lights. If a proper installation were made there was small danger of fire, but it was absolutely necessary that the installation should be perfect. Although great progress had been made in London with the electric light, London having a lighting power equivalent to half a million 8 c.p., we might expect in the near future to see this greatly enlarged. Electric lighting was dearer than gas, but it had many compensations. Describing the Manchester installation, Mr. Gee remarked that it was the only five-wire system in the kingdom. In Paris the five-wire system was found to work well. He believed that the Manchester installation would be of very great advantage. A vote of thanks was accorded the lecturer.

Economic Considerations.—The current journal of the Manchester Association of Engineers contains the full text of Mr. B. H. Thwaites's paper on the generation of E.M.F. in the coalfields, and the discussion thereon. The paper will be found in our issues of last December, but some points in the discussion may be noticed. It is interesting to know that Mr. T. Ashbury, a past-president of the association, was associated with Mr. Wilde in producing the first electric searchlight which was put on any vessel. It was put on a steam vessel in the Thames, and subsequently four similar lights were ordered by the Government for men-of-war. Therefore Manchester claims the credit of putting the first electric searchlight on any English vessel. Several members who had installations in mills took part in the discussion, and Mr. Barthane remarked that four years ago an installation was put down at Portwood Mills, Stockport. The dynamos were run from the mill engine, "and the installation, by their own calculations and tests, showed that a clear saving of 10 or 12 per cent. had accrued as compared with gas." In a short communication sent to the association, Mr. J. Swinburne called attention to the apparent neglect of engineers to enquire into the possibilities of electric motors, and contended that "as soon as electric motors are familiar to engineers and millwrights, belting, pulleys, and shafting will disappear. It is only a question of time."

Journal.—We have received the issue of the *Journal* of Electrical Engineers which contains the continuation of the discussion of Prof. Fleming's paper on transformers. Prof. Fitzgerald's remarks on the eddy currents are suggestive with reference to minor effects which may become important. Prof. Perry's explanation of the voltage drop in transformers is given in full. Mr. Sparks gives a good deal of practical information on Ferranti transformers. The method of measuring true watts in the workshop is thus given: Not having facilities for measuring the watts on the high-pressure side, the efficiency of two transformers is always taken together. The watts are measured on the low-pressure side, the two high-pressure sides are connected together, and the energy is taken from the second low-pressure side. The efficiency is then taken and the losses divided. A Siemens dynamometer is used. Prof. Kennedy puts it on record that he thinks a serious error of judgment has been made by those who insist that loss due to magnetising current might be neglected if the transformers had a high efficiency all round. High efficiency is important, but where separate transformers are used something in the efficiency could be sacrificed if we could diminish the frightful loss occurring with open secondary. From two-thirds to five-sixths of the whole losses are due to this cause. During the lower day loads the work is often doubled, and instead of getting (as at St. Pancras) even 3d. a unit, it has to be done for nothing. Mr. Preece's presidential address also appears in full in this number of the *Journal*.

Catalogue.—Messrs. Johnson and Phillips are well in evidence this week at the Paddington electric light station, and their catalogue of electrical machinery comes opportunely. For solid engineering and workmanlike electrical apparatus there are few firms that stand higher in the world. Kapp dynamos and Brockie-Pell arc lamps are well known by everyone dealing with electric light, and these are magnificently illustrated in this catalogue, which bears upon its front page fac-similes of the gold medals obtained at the Crystal Palace Exhibition. The continuous-current machines are first illustrated, and lists are given of types giving current 55, 65, and 105 volts, with full details and code words for quick ordering. The combined sets have a good reputation—the Willans-Kapp combination supplied by Messrs. Johnson and Phillips when tested had a record combined efficiency of 84·6 per cent., the electrical efficiency being 96 per cent., and the water consumption 27lb. per electrical horse-power hour. The Davey-Paxman-Kapp set which drew much attention at the Crystal Palace Exhibition, here is accorded honoured place. For large low-pressure current central stations, these large steam dynamos, direct or belted, are specially designed, and have been used in the most celebrated stations. St. Pancras has 11 of them, all remarkably efficient and effective. A photograph of this vista of dynamos is given in the catalogue, as well as handsome photographs of the Brockie-Pell lamps in Tottenham Court-road for the same Vestry. "D.P." accumulators, measuring instruments, cables, and insulators are also illustrated. A set of code words completes a very handsome catalogue.

Electric Towage and Electric Brakes.—The attraction of iron to iron in electromagnetism, as is well known, increases enormously as the distance diminishes, and at actual contact is at its highest effectiveness. The force of this magnetic contact can hardly be said to have been utilised in practice to the extent that it might easily be made to do. Electric brakes form one application of surface magnetic attraction that has been attempted with some success in England, notably a year or two ago, at Sutton Coldfield for railway carriages; but we do not remember to have heard of any very extensive use of this electric brake, notwithstanding that its employment seems attended with advantages in quickness of stoppage. M. de Bovet, in France, has recently taken up the problem and elaborated a method of electrical towage of barges in order to decrease the length of chain that must be used to obtain the necessary adhesion by mechanical means. He has also applied it to brakes for fast and loose pulleys and for railway trains with some success. The great advantage of electrical friction is that the adherence is obtained with no exterior action—the magnetic forces are all exercised in an interior closed circuit, so that strong elastic pieces are not necessary. The dimensions of the apparatus needed are also small, and the regulation of brake power easy. The utilisation of magnetic forces at surfaces would seem to offer some field for further investigation and experiment, and as electricity more and more invades the provinces of mechanical science, its utilisation may become increasingly important.

Electricity in Chemical Laboratories.—The employment of electricity in quantitative analysis is now a definite branch of chemical work, but an extended service, says *L'Electricien*, may be rendered by electricity in chemical laboratories. A new method of purification of mercury may be mentioned, due to Herr Jaeger, of the Physical Institute of Berlin, based upon the electrolysis of nitrate of mercury to precipitate alkaline metals and zinc; the use of the electric crucible may be also applied with equal success to many other reactions. But for all these applications a source of current is required. Up to the present the Bunsen cell has been the favourite source; but the numberless minor troubles which accompany the use of batteries encourage the use of other means. It is true the number of central stations are constantly increasing, and soon every town of any importance may expect to have its public supply. But until this happens it is certain that many experimenters are often stopped for want of convenient source of supply. An original installation made by Dr. Karl Elbs, at Freiburg, and described in the *Chemicker Zeitung*, is therefore worthy of mention. The primary source is a Gulcher thermopile of 66 elements, which charge eight accumulators of a capacity of eight ampere-hours each. They are divided into two groups, which can be connected in different ways. The thermopile is heated by gas, its voltage is 4·1 volts and its interior resistance 0·88 ohm, so that a maximum of about six watts can be obtained, and for this the consumption of gas per hour is 180 litres. The accumulators are of the type used in the German telegraph office, with three plates only, giving a maximum output of three amperes. They are charged in parallel, and a complete charge is given in 30 hours; but as a rule they are kept constantly charged. It has not been found necessary to protect the various instruments from the fumes of the laboratory, and the serviceableness and convenience of the installation has been much appreciated.

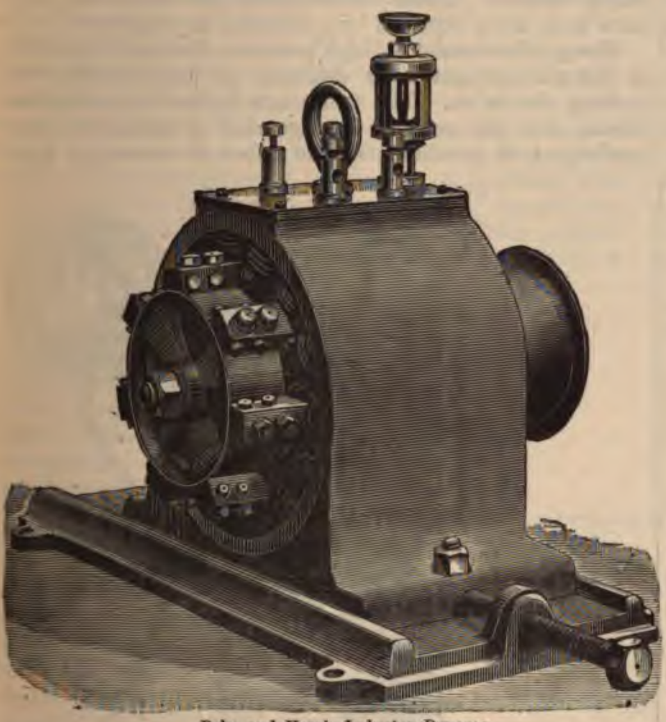
Electric Manufacture of Chloral.—The preparation of chloral is thus carried on electrically, according to the *Revue de Chimie Industrielle*. In an alembic, separated in two by a porous partition, is placed a hot concentrated solution of chloride of potassium; in one compartment is placed the positive plate formed by a plate of carbon with rough surface, and in the other a plate of copper. A strong current is passed sufficient to disengage chlorine freely in the positive compartment, and gradually a thin stream of alcohol is brought in. A better result is obtained by making the carbon plate act as agitator to mix the alcohol, and the liquid charged with chlorine. For 100 grammes of alcohol there will be required 220 litres of chlorine, or 316 grammes, corresponding to the decomposition of 600 grammes of potassium chloride. A horse-power hour gives off 64·5 grammes of chlorine. With these data, the dimensions of the apparatus and the power required to produce a given amount of chloral can be calculated. The operation must be carried out at 100deg. C. At the commencement of the reaction a considerable quantity of hydrochloric acid is generated; this is given off from the positive compartment, bubbling into the negative compartment, where it forms caustic potash, and regenerates the chloride of potassium; the excess goes off by a tube into the chimney. Hydrated chloral is thus obtained. The liquid is distilled until what passes is not clouded on testing by a solution of potash. The distilled liquid is saturated with sea-salt or chloride of potassium to separate the chloral hydrate under the form of a oil which is decanted and distilled on sulphuric acid, collecting the principal product between 94deg. and 99deg. if chloral anhydrate is required. One horse-power produces 50 grammes of chloral. The same process applies for obtaining chloral from sugar glucose or starch. Preference should be given to glucose, which is dissolved in a solution of chloride of potassium. A strong current is passed as explained; 100 grammes of glucose require 90 to 100 grammes of chlorine to effect the transformation. One horse-power hour, in the experiments conducted, only gives 20 grammes of chloral.

Diamond-Making by Electricity.—M. Henri Moissan has made a preliminary communication to the Académie des Sciences on the production of varieties of carbon, amorphous carbon, graphite, and diamond. Analytic experiments were first carried out, which have enabled him to determine the composition of diamond ash, to discover the presence of miscroscopic diamonds in the Cape blue clay and certain new properties of crystallised carbon. These first researches have led M. Moissan to study the solubility of carbons in certain metals, such as magnesium, aluminium, iron, manganese, chromium, uranium, silver, platinum, and in a metalloid—silicium. In the course of these researches he has obtained new varieties of graphite, but not carbon of great density. M. Moissan then made experiments, using great pressure, under the following conditions. Sugar carbon is strongly compressed in a soft iron cylinder, closed by an iron screw. In an electric furnace 150 to 200 grammes of soft iron is melted, an operation only requiring a few minutes; then in this molten liquid is rapidly placed the cylinder containing the carbon. The crucible is drawn out of the furnace and dipped in a bucket of water. A crust of solid iron is thus rapidly formed, and when this crust is a dark red the whole is taken out of the water and allowed to cool in air. The metallic jacket is then attacked by boiling hydrochloric acid until no further reaction of iron salts is apparent. There remains three kinds of carbon — some graphite, a small quantity only if the cooling has been quick; a carbon of chestnut colour, in thin twisted strips, seemingly subjected to strong pressure; and, finally, a small quantity of dense carbon. To separate the latter, it is treated successively and several times over by nitric acid, boiling sulphuric acid, and hydrofluoric acid, then by chlorate of potash and fuming nitric acid, and, lastly, by bromoform. Certain small fragments which scratch ruby are obtained; these, when heated in oxygen at 1,000deg. C., disappear. Some are of a dark grey tint, seemingly identical to ordinary black diamonds; others are transparent with greasy surface, absorbing light, and bearing parallel and sometimes triangular striæ, and their combustion leaves an ash in every way identical with diamond ash. Other methods have furnished fragments of diamonds similar to those found in the blue clay. Carbon sugar, heated in boiling silver and suddenly cooled, yielded black diamonds. Of the whole number of experiments carried out by M. Moissan a few only have yielded very small transparent crystals, but these have been obtained, and the artificial production of diamonds has therefore been accomplished. These results, we may add, are similar to those obtained some time ago by Mr. Hannay in Scotland, but by a rather different process.

Electric Motors for Factories.—A lecture on "Electricity as a Motor Power for Factories" was delivered by Mr. Alexander Siemens before a large audience of the Birmingham Association of Mechanical Engineers at the Grand Hotel, Birmingham, on Saturday last. Mr. A. Driver, president, occupied the chair. Mr. Siemens stated the pleasure it gave him in addressing a Birmingham audience. His lecture was illustrated by some excellent diagrams, and there was also exhibited a number of electrical appliances, their construction and use being fully explained. The simplicity of the construction of the machines, he said, was very marked, and that was the first point he brought before the notice of his audience. Little attention was required to look after such appliances as compared with machinery for other motive powers. Allusion was made to two locomotives which had been constructed by Messrs. Siemens, and, after they had each run 20,000 miles, one was inspected by Lord Kelvin, and the result was highly satisfactory. The first set of brushes were still in use, and to have a motor to run 20,000 miles, and, say, using only one pair of brushes per year, could not be considered serious. Sir William Siemens had proved the advantage of saving both expense and trouble by using an electric motor in his garden for pumping water, in place of driving a steam-engine. Electric motors, besides being quite compact, were very light in weight, considering the power they exerted. There was no necessity for providing heavy foundations, as required when other powers were provided. The ideal way of applying any electric motor was that every machine tool should get its electric motor, and so dispense with strong columns for buildings, and to avoid the use of shafting, countershafting, banding, and pulleys—all these being a consideration on the capital outlay. He then referred to the alterations which had taken place at their works at Woolwich, where electricity had superseded steam at a saving of a considerable amount of space, of £800 a year in wages, in addition to a large quantity of coal, which they must admit was a great consideration in maintenance. In the transmission of power there was a saving by the adoption of electricity, as shown by an engineer who read a paper before the Belgian Society of Engineers on the construction of the small-arms factory at Liège. The calculation as to what would be the best way of obtaining power was carefully gone into; whether to have one or two steam-engines, and then as to how to transmit the power, whether by shafting and belting, by ropes or electricity. The results were that with electricity he was sure he could count on 70 per cent. of the indicated horse-power being rendered at the machines, and with the shafting not more than about 60 or 63 per cent. could possibly be obtained. Electricity was, therefore, decidedly superior to the other method of transmission. By the establishment of central stations, small works could obtain electric power. They would then be able to have the facility of being placed much more on the footing of large works, as far as their source of power was concerned, but as to how that system would develop it was very difficult to foretell. It was quite certain that electrical motors for industrial purposes generally would make a lasting impression, and that they were of the greatest possible importance for the future development of their industries. A discussion followed the reading of the paper. The chairman moved a hearty vote of thanks to the lecturer for his instructive and valuable address.

LIGHTING BY PHOSPHORESCENT TUBES.

We have had the pleasure of introducing the electrical public to a goodly number of advances in science during the last few years, and of explaining with as much clearness as possible the principles, at first seemingly somewhat tangled, upon which the practical results are based. High-tension work generally has developed with leaps and bounds, rotary current has stepped into the field, high-frequency currents have yielded results seemingly magical, and in all this those most antique pieces of apparatus, the Leyden jar and the Ruhmkorff coil, have played an important, and ever-increasingly important, part. The Geissler tubes, invented in the very early days at Bonn, having long served as the standing wonder of gaping crowds at popular lectures when whizzed around in circles and displayed in letters of phosphorescent light, or discoursed upon by scientists in lecture theatres in fascinatingly interesting considerations of molecular bombardment, these tubes now are receiving the earnest attention of electrical experimenters with the fond and not chimerical hope that in the illumination of the tubes lies the desired secret of practical lighting by glow-worm or phosphorescent light—light without heat. 'Tis a consummation devoutly to be wished; and the rich reward that is promised to the inventor of true "glow" lamps is certainly not less than awaits the inventor of "electricity direct from heat."


Pyke and Harris Inductor Dynamo.

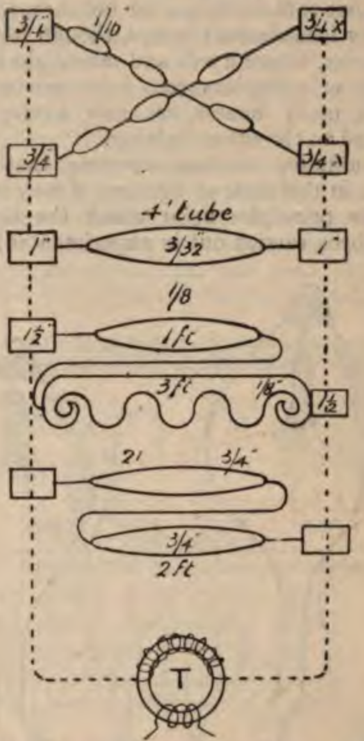
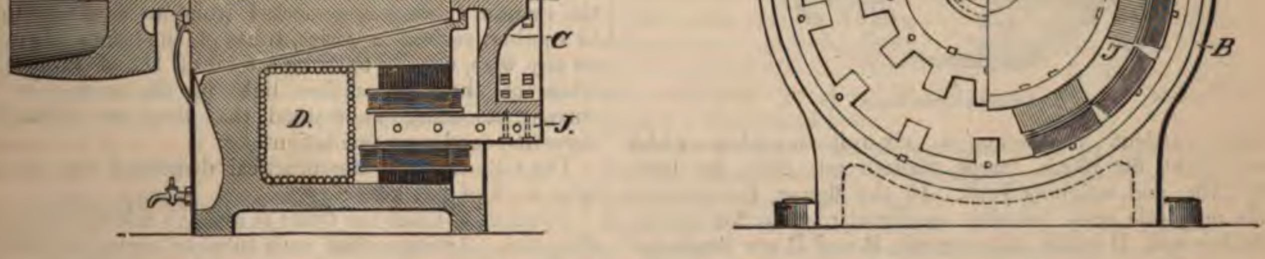


Diagram of Connections for Phosphorescent Tubes.

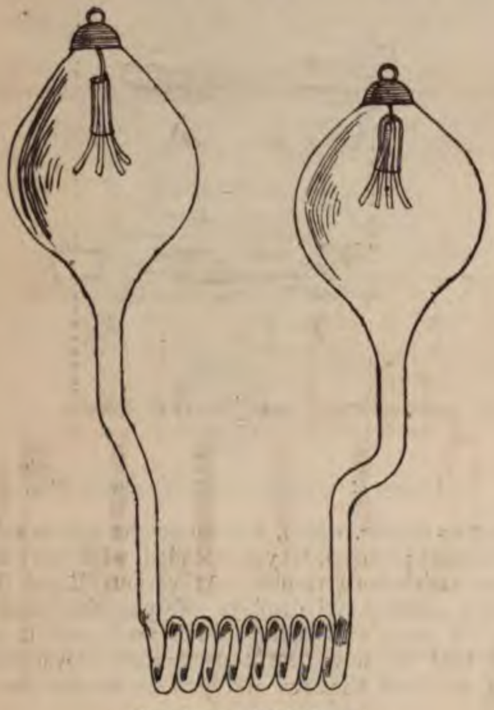


Pyke and Harris Inductor Dynamo. Section.

Amongst the experimenters who have done much in a quiet and persistent way in the domain of extreme high-tension and vacuum-tube research are Messrs. Pyke and Harris, who, together with Sir David Salomons, have carried out the practical utilisation of phosphorescent tube lighting to a degree, which, if it cannot be said to solve the long-discussed problem, is yet attended with very suggestive and satisfactory results. At various Royal Society and other *conversazioni* displays of phosphorescent tube lighting of some extent have been made, and it is with interest that we have learnt particulars of vacuum-tube lighting for both theatres and private houses that have been carried out on the system thus brought forward. At the works in New Tothill-street, Westminster, Mr. Pyke, in conjunction with Sir David Salomons, has been carrying out a number of experiments in this interesting and enticing field of research. Quite a large glass-blowing laboratory is kept going for the production of all kinds of vacuum tubes—a very favourite form now adopted being that of a closed coil, or spiral of thin glass tube, between two small bulbs. This coil, when made phosphorescent, gives out a fairly brilliant cool light, using, it is calculated, about one watt per foot of tube lighted.

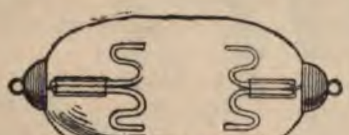
The difficulty with these tubes is that when brilliantly phosphoresced they become heated, and there is trouble from melting of the glass after some interval of use. A further difficulty has been the necessity for the use of condensers to properly light the tubes, and condensers are both frail and cumbrous. In any case the light is never very brilliant—not sufficiently so, for instance, to take the place of ordinary incandescent lamps, though for the lighting of conservatories, where a soft and moonlight effect is desired, the groups of phosphorescent tubes produce an admirable effect, and many houses are now having such "glow" lamps added to the other lighting.

Before alluding to improvements that have recently been made in this class of lighting, it may be interesting to explain the principles upon which the lighting of these tubes has been carried out in experimental form.



Phosphorescent Tube Lamp.

An alternating current is, of course, necessary, and the inductor machine recently patented by Pyke and Harris is a very convenient form of dynamo to be used for private installations, being small, cheap, and compact, though for town houses the alternate currents from the supply mains can be used. This inductor dynamo is herewith illustrated, and is worth the attention of engineers. The woodcut represents a six-unit machine, which will light 60 16-c.p. lamps, though but 20in. by 15in. by 21in., and weighing 7cwt. In the figure, B represents the magnetic mass forming an annular space for the inducing coil, D is the inducing coil, R and R are laminated rings with polar projections wound with armature coils, J J are laminated inductors which alone rotate, and the completion of the magnetic circuit causes the current. It will be noticed that the whole arrangement of the machine is far more solid than any other dynamo as yet in use, and for the same space occupied is the most energetic. The whole machine consists of two castings, some iron stampings, and wire coils, and is thus very cheap to construct. Like machines worked on the inductor principle, it has the advantage of no rotating wire; and a further advantage is that, in case of the failure of one or several of the coils, there is a fuse arrangement attached to each connection which melts before the current from the active coils passes into the defective one.



Uranium Spray Lamp.

To light the vacuum tubes, a tension of 50,000 or 100,000 volts is desired, and this is produced by a specially-wound transformer in oil, of the type that Messrs. Pyke and Harris patented and have produced for some years. This transformer is plunged in dehydrated oil, which is kept in circulation by an arrangement of tubes like those in hot-water heaters. These transformers are expensive, and have been lately replaced by a different arrangement.

Having the current at high pressure, the next question is the arrangement most desirable in practice for connecting the tubes. The tubes are lighted by induction effects, and the peculiar arrangement of connecting the condensers in parallel and the tubes in series is here illustrated for the first time. Mr. Pyke has made careful experiments, and finds that to properly phosphoresce tubes of 1in. internal diameter one square foot of tinfoil condenser is required. To light tubes of $\frac{1}{16}$in. diameter, which have been generally employed, condenser sheets $\frac{3}{4}$in. square are therefore required to give the desired effect.

Pyke and Salomons' Combination 5,000-volt Transformer.

On one side of a glass plate a number of condenser sheets are arranged of the size desired, and these are all connected in parallel to the high-tension circuit, as shown by dotted lines on the figure, the dotted lines representing the under side of the sheet of glass. On the upper side, the vacuum tubes are connected from one condenser plate to another, several in series, tubes of the same kind only on any wire, usually to make a total of 1ft. of tube. The whole of these tubes then light up on turning on the current, it being understood that they are lighted by induction condenser oscillations.

The following are the practical directions for vacuum-tube work of this kind:

Directions.—Class the tubes in average minimum internal diameter. Arrange that each tube or series of tubes in the various circuits have the same length. Tubes in each class only must be worked in series. Imagine the tubes electrically connected, then arrange the inductors so that one square foot of foil ($\frac{1}{16}$ glass) to each square inch of diameter. Above 1in., the current should be graduated more by the surface of the aluminium wire. Any difficulty may be overcome by cutting off one or adding to both inductors.

So far with the methods hitherto used, now to be discarded. The difficulties are apparent — special dynamo, expensive transformer, cumbrous condensers. Experiments have been made to do without the condensers, and to construct a small but powerful transformer which can be used direct. A small closed-circuit transformer has been designed by Sir David Salomons and Mr. Pyke for use in conjunction with the supply companies' alternating-current circuits, intended to raise the potential from 100 to 5,000 volts. This is probably the smallest closed-circuit transformer yet made, and is very cheap to make, as it is capable of being sold for £1 for ordinary and experimental use. The illustration shows it attached to ordinary 100-volt mains.

The quantity of current which it furnishes at this potential is sufficient to very brilliantly illuminate vacuum tubes. Indeed, so bright are they, that the photograph from which the above illustration is reproduced was taken solely by the light of the tubes suspended from the secondary terminals. The transformer, it will be seen, is provided with an attachment in the form of the usual "B.C." lampholder, the primary winding being connected to the brass contact-plates. This is a great convenience, as the connection is made, and the transformer securely held, in any conveniently placed lampholder.

We understand that Sir David Salomons intends proceeding further in the same direction, and will shortly introduce a combination similar to the above, but with the vacuum tubes permanently fixed thereon, and arranged to form an ornamental illuminating device which can be used in conservatories and other places where beauty is of more importance than a very brilliant illumination.

The curled phosphorescent-tube lamp used in these experiments is here illustrated. In practice the two bulbs are hidden, the glass spiral only being visible, and several of these lamps may be easily arranged to form letters or words. A newer form of uranium tube is also illustrated, in which the electrodes are in the form of a spray. A large number of these tubes can be connected in series, and lighted from the combination transformer.

The transformers are made by winding three primary circuits of No. 22 wire—one at each end and one in the middle—over boxwood bobbins, with the secondary of No. 40 wire in between. The whole is then wound longitudinally over and over with fine iron wire till the central core is filled, making a small and solid bundle which can be suitably covered with velvet or other material. The vacuum tubes can be mounted thereon. One very convenient point is, as they are furnished with an ordinary lampholder bayonet joint, current at 5,000, or perhaps even 10,000 volts will be within the reach of ordinary experimentalists at a mere nominal cost. The current going into these transformers is only ½ ampere at 100 volts, and the current at the higher voltage is therefore infinitesimal—not sufficient, in fact, to give more than a slight shock.

It will be evident that high-tension currents are now within the reach of all, and we may expect further developments in this fascinating field of phosphorescent tube lighting.

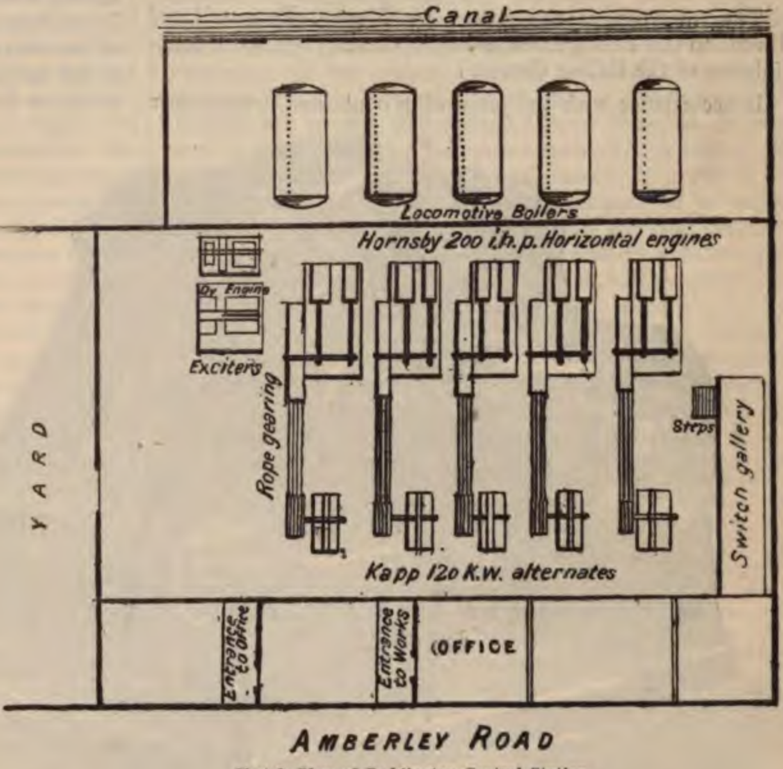
PADDINGTON CENTRAL STATION.

The Paddington Vestry decided, some 18 months ago, after much discussion, not to follow the example of St. Pancras by having their own central electric station. In so doing they have given up the hopes of the distribution of electricity at the lowest prices to their ratepayers, with perhaps the chance of a substantial contribution in the near future towards the rates in the shape of profits. But the district of Paddington has, nevertheless, its central station—and a fine one, too—erected by the Metropolitan Electric Supply Company, to whom will be the glory and the profit of supplying the district with electricity.

The station has been complete and in working order for some months, but it was only on Friday last that a kind of inaugural ceremony was performed, on the visit of the members of the Paddington Vestry to the new station to meet the directors of the company. Among those present were Sir John Pender, M.P. (chairman of the company), Mr. J. D. Pender, Sir George Elliott, Admiral Sir G. H. Richards, Sir Eyre M. Shaw, Mr. J. C. Parkinson, Mr. J. B. Verity, directors; also Colonel Barchard, Mr. T. G. Fardell, L.C.C., Mr. Frank Dethridge (clerk to the Paddington Vestry), and many members of the Vestry.

The station is situated at St. Peter's Wharf, Amberley-road, a few minutes' walk from Royal Oak Station on the underground railway. Being on the bank of the canal, the site has the advantage of both road and water access.

The boiler-house, with coal-store adjoining, fronts the canal. The engines and dynamos, with their switchboards, are placed in a high and roomy machine-room, taking up most of the site, and the offices front the road, the upper floors over the offices being planned for the accommodation of the staff required in working the station. It is interesting to note that the buildings were designed and erected by the company's own staff, Mr. Mark Judge, F.R.I.B.A., being the consulting architect. The building work was carried on through the recent strikes in the building trade without interruption.



Sketch Plan of Paddington Central Station.

The generating machinery consists at present of five sets of horizontal engines, driving alternators of 120 kilowatts capacity each by rope gearing. The total capacity is therefore at present 600 kilowatts—viz., 600 amperes at 1,000 volts, sufficient for about 25,000 8-c.p. lamps. There is space for three more sets.

The whole of the contract for machinery has been carried out by Messrs. Johnson and Phillips, of Charlton, Kent, with sub-contracts for engines and boilers to Messrs. Hornsby, of Grantham; to Messrs. W. H. Allen and Co., of Lambeth, for direct-coupled exciter sets; and to the Indiarubber Company, of Silvertown, for mains. The work has been admirably carried out, and reflects the greatest credit all round.

The five boilers are of the locomotive type, by Hornsbys, and are about 230 h.p. each, working at about 145lb. pressure. The five engines are of a well-known and well-tried type—horizontal compound, with high and low pressure cylinders driving huge flywheels grooved for rope gearing. The oiling arrangements are carefully considered, and the engines work with the greatest smoothness. On the day of the inspection, one of these engines had its steam-chest cover, slide-valve, and cylinder end taken off, and the interior working was shown to the visitors by the engine being driven by its dynamo working as an alternating-current motor.

The dynamos are the latest type of Kapp alternator giving 120 amperes at 1,000 volts. They are bolted to the foundations by dog-bolts to allow of adjustment of rope gearing. The centre of the armature of each dynamo is being covered in with smooth plates to prevent the useless churning of the air and humming from the exposed arms of the armature.

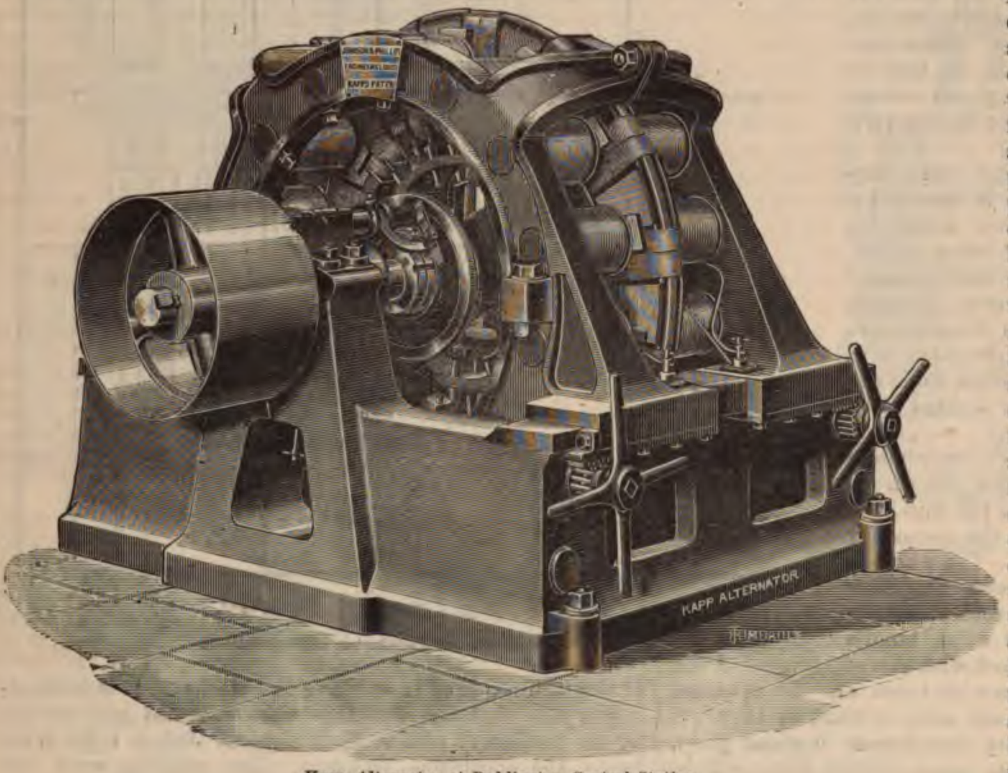
The alternators are excited in parallel from a continuous-current Kapp dynamo, direct-coupled to a vertical engine, forming the usual ship set of Messrs. W. H. Allen and Co. There are two such sets of exciter plants, one being spare.

(To be continued.)

EALING LIGHTING.

The following is the report by Messrs. Bramwell and Harris to the Ealing Local Board upon the proposed electric lighting of the Ealing district:

In accordance with the intimation contained in the letter of your surveyor, Mr. Jones, received by us on the 20th of December, that the Local Board desired us to report as to the best scheme to be adopted for lighting the district, we have made a careful inspection, and have given the matter our earnest attention and consideration, and we now beg leave to report to you for the information of the Board as follows: We think it well to direct attention to three or four important points which will require the consideration of the Board, before the adoption of electric lighting in the district can be finally determined upon. These points are: A. Is it desirable, or not, that the Board should undertake the lighting themselves, or should they transfer the powers afforded them by the Ealing Electric Lighting Order, Sessions 1891, to some company or contracting firm ? If it is desirable the Board should themselves undertake the supply of electricity, then: B. What is the best method of supply (electrically speaking) to adopt ? C. What will be the first cost of establishing a satisfactory installation ? and D. What are the probabilities of a return being realised by the undertaking, and when is such return likely to accrue ?



Kapp Alternator at Paddington Central Station.

As regards the first question: A. "Is it desirable, or *not, that* the Board should undertake the lighting themselves, or should they transfer the powers afforded them by the Ealing Electric Lighting Order, Sessions 1891, to some company or contracting firm ?" We are of opinion, as we shall show later on in this report, that there are peculiar circumstances connected with the case of Ealing which render it desirable that the Local Authority should itself undertake the lighting of its district.

Head B is as follows: B. "What is the best method of supply (electrically speaking) to adopt ?" The district over which the jurisdiction of the Local Authority extends is one covering a large area (some five square miles), and we find that the streets scheduled in the Ealing electric lighting order, wherein the mains have to be laid, and electricity at once supplied (hereinafter called the "obligatory area") do not lie in a small compass, but extend the whole length of the district from east to west (some two miles), and also extend from north to south (some one and a quarter miles). Further, in connection with this head "B," the question as to the site available for the electric light generating station has to be considered. Upon this point we learn from Mr. Jones that there are two places in Ealing where there is land, already the property of the Local Board, which might well be employed for the erection of the electric generating station: (1) A piece of land nearly at the extreme west of the district and close to the railway, known as the Drayton Green siding, and (2) the spare piece of land at the sewage and destructor station, which is at the extreme south of the district. We inspected both these sites. As regards the first, we found the area was amply sufficient for the purpose, and that, owing to its proximity to the railway, coal could readily be delivered there. If there were not other considerations which render the second site more satisfactory we should have no hesitation in recommending you to erect the electric lighting station at the Drayton Green siding, although its electrical position is not as central as could be desired. The second site—that at the destructor or sewage station—is, as we have said, at the extreme south of the district to be supplied. Electrically speaking, therefore, its position is no more satisfactory than site No. 1, but on inspection we found that this apparent disadvantage was not, owing to the proximity of large houses (likely to require the light), so great as, at first sight, it seemed to be; and, further, we found there were other advantages (to which we will next call attention) which counterbalance this disadvantage, and render the site, in our judgment, very satisfactory; and we most strongly recommend that some of the spare land there should be utilised for the erection of the lighting station. It will be remembered that the dustbin refuse of the district (which the Local Board themselves collect) is burnt at this station to destruction in the destructors and the "fume cremator"—the latter the invention of your surveyor, Mr. C. Jones. In order to satisfactorily complete the process of destruction of this refuse a great heat has to be generated by the "fume cremator." A portion of this heat is already employed to generate steam, which is used to drive the engines in the sewage works, but a considerable portion still passes away to waste in the chimney, and some of this may well be utilised to assist in generating steam for the engines driving the electric light plant. Further, one of the needs of an economically working electric lighting station is a large supply of water for steam-condensing purposes. We find upon enquiry that there is no place in Ealing where such a supply can, with certainty, be obtained, unless it be from the water company's mains, and the expense of the water purchased in this way would probably be such as to render its use prohibitory. At the sewage station there is at present passing away some 600,000 gallons of sewage effluent per 24 hours; this sewage effluent has been brought by your processes to such a state of excellence that, before it leaves the premises, it could be satisfactorily employed for the purposes of steam condensing. These two advantages, therefore—(1) the utilisation of the waste heat from the destructors, and (2) the utilisation of the sewage effluent for condensing purposes—with the further advantage that there is (as we have already said) at the sewage station spare land sufficient for the purpose, render it, in our judgment, unquestionable that the electric lighting station should be erected there, and that the Local Authority should themselves undertake the supply of electricity in their district. The disadvantage of this site for the lighting station is its position on the extreme southern edge of the district; in other words, it is some considerable distance away from certain portions of the area which will have to be supplied with electricity. It is apparent, therefore, that any system of low-pressure electrical distribution, either with or without storage batteries, would be "economically" out of the question, and we are of opinion that a high-pressure alternating-current system with transformer stations, such as we are at present erecting for lighting the borough of Derby, should be adopted, as with such a system the disadvantage of the "electrical position" of the station is considerably minimised. Further, if an installation such as we have proposed be established at the sewage station, the disadvantage of being unable to employ storage batteries because of the alternating current will not be of importance, as, during the greater portion of each 24 hours, the waste heat of the destructors will be sufficient to do the whole work

As regards heading C: "What will be the first cost of establishing a satisfactory installation." It is necessary to consider what will probably be the needs for public lighting and for private lighting, and the questions at once arise of: (1) What, if any, public lighting would it be advisable for you to undertake electrically, thus displacing the gas lamps, and saving the annual expenditure on these; and (2) what probability is there of the electric light being adopted in your district for private purposes within a reasonable time after the establishment of the station. As regards the first of these two questions, Mr. Jones informs us that the gas lighting in the scheduled streets (where, under your electric lighting order, the mains have to be laid, and electricity at once supplied) costs you a sum of £500 per annum; and also that the lighting of the town hall and other public buildings cost a sum of £250 per annum. These amounts, together £750 per annum, would at once be saved by the establishment of the electric light; or rather, to put it more accurately, would at once become a revenue for the electric lighting station. With respect to the private lighting. As we have said, we have carefully inspected the district, and have made such enquiries as seemed to us likely to enable us to come to a satisfactory conclusion, and we think, having regard to the class of the inhabitants, it is very probable that when once the electric light is established a reasonable amount of business for private lighting (the lighting of shops, banks, etc.) may shortly be anticipated. The second of the above questions is one, however, upon which the Local Board themselves (with their intimate knowledge of the district and its needs) are much more competent to express an opinion than we can possibly be; but remembering the size of your district, the character of its shops, private houses, etc., we are of opinion it could not be considered a sanguine estimate if you assume that, at the expiration of three years from the date of establishing electric lighting, the demand for private lighting would be equal to 5,000 lamps (each of 8 c.p.) installed. In our judgment, therefore, the station should be so designed as to admit of ready and easy extension as the demands require it, but should, in the first place, allow of this number of lamps being installed for private lighting, in addition to the public lighting necessary for the streets scheduled in the electric lighting order. We estimate the cost of providing on the ground which we have seen at the sewage and destructor station, an electric generating station, with buildings, boilers, machinery, mains, street lamps, etc., complete and at work, and designed so as to utilise the waste heat from the destructors and the sewage effluent for steam-condensing purposes, this station being capable of supplying electricity for the public lighting of the 3¼ miles of streets first to be lit, as well as for the private lighting of 5,000 lamps, of 8 c.p., installed at the sum of, say, £21,000.

As regards head D: "What are the probabilities of a return being realised by the undertaking, and when is such return likely to accrue?" This, perhaps, is the most difficult question for us to deal with, but speaking from the experience of other towns and districts, there is not much doubt that when once electric light begins to be taken up the increase in demand is very rapid indeed. Take, as an instance, the lighting of shops. One enterprising tradesman in a street determines to take the light and his neighbours will speedily follow his example, and thus the increase in demand when once it commences is very rapid. It cannot be assumed that from the first the installation will be worked at a profit. The Board will, of course, realise that the working expenses of an electric lighting installation, like the working expenses of any other factory, do not increase in anything like the same ratio as the output—that is to say, when the installation is started the expenses will certainly be in excess of the revenue, and until a large percentage of the output is being sold the revenue and expenses will not balance. With further development the revenue will exceed the expenses; and when an enlargement of the installation becomes necessary, the cost of this enlargement will not be proportionately as great as the first cost, and it will enable a larger revenue to be earned with probably but little increase in the working expenses. We estimate the annual working expenses of a station such as we have recommended—when fully at work—exclusive of the annual amount necessary for the repayment of principal and interest on the first cost of £21,000, and exclusive of rent of land, rates, and taxes, as follows: Annual cost of the lighting (when the whole of the 5,000 lamps, each of 8 c.p., for the private lighting are installed, and the, say, 70 public (arc) lamps are also installed):

Coal, slack, say	£210
Superintendent of installation, engine-room staff, outdoor staff, linemen, etc., say	700
Small stores, oil, etc., say	40
Carbons for arc lamps, say	100
Actual working expenses	£1,050
Depreciation—repairs and renewal fund at various percentages according to the nature of the item, but averaging 5 per cent on total cost	£1,100
Total annual cost	£2,150

Revenue.—Public (Arc) Lighting.—As we have already pointed out in regard to this, the electric lighting station would at once enter upon a revenue equal to the annual cost of the gas lamps displaced, in the streets which are lit electrically, and of those displaced, in the public buildings, together, £750 per annum. It must be remembered, also, that, in fairness, an addition should be made to this amount for the fact of the far superior illumination afforded by the electric light. We do not, however, make any addition for this to the above sum.

Private Incandescent Lighting.—Assuming that the charge for the supply of electricity is equal to 8d. per Board of Trade unit (the price contemplated by the Ealing electric lighting order), the average revenue to be derived from each 8-c.p. lamp installed may be taken as the sum of 9s. With the whole 5,000 installed, the annual revenue from this source would therefore be £2,250. The total annual revenue would therefore amount to

Public lighting	£750
Private lighting	2,250
Together, say	£3,000

The difference between the above—

Sums of revenue	£3,000
And working expenses	2,150
That is a sum of	£850

represents the annual amount which could be devoted to rates and taxes, and to the repayment of principal and interest on the sum of £21,000, the first cost of the installation. From the above it will be seen, therefore, that when the demand is such as to absorb the full capacity of a station such as we recommend, the undertaking will be practically self-supporting, and this condition of things will improve from time to time as the number of lamps increases beyond the 5,000, because while the revenue increases by each additional lamp, the working expenses would not increase in anything like the same ratio.

We cannot close this report without requesting permission to be allowed to refer to the extremely valuable information as to destructors and their capabilities, and to the valuable suggestions which have been made to us by Mr. Jones, and to tender him our thanks for these. Should any matter have been omitted from this report, or should the Board desire any explanation from us of any part of it, we should be pleased to attend a meeting of the Board, or of any committee, upon receiving an intimation to that effect.

LEGAL INTELLIGENCE.

ALABASTER AND OTHERS v. THE MEDICAL BATTERY CO.

This case was heard on Tuesday and Wednesday in the Queen's Bench Division, before Lord Chief Justice Coleridge and a special jury.

This was a novel and important action—the first of the kind—an action by the proprietors of a periodical for a circular to newsagents describing it as libellous, so deterring them from selling it. The case had arisen out of the controversy which has been carried on for some time between the *Electrical Review* and the company as to the medical use of "Harness's electropathic belts," which the company sell, having also an "institute" in Oxford-street, at which, it was stated, 16,900 cases have been electrically treated during the last six or seven years. Dr. Tibbits had published a book in favour of the belts, which the *Electrical Review* had criticised rather severely, and an action was brought by him against the proprietors, and has been tried at these sittings, before Mr. Justice Mathew, resulting in a verdict in favour of the *Review* (and another action is pending). The history of the present case appeared to be, shortly stated, this: The *Electrical Review* had published some articles against the sale of the belts for medical purposes, on the double ground that they could not generate electrical currents in the body, and that if they did they would, in most cases, be useless; and that their general sale and recommendation for the cure of all sorts of diseases and disorders were delusive, and, in short, a species of imposture. The company, through their solicitor, had issued a circular to the newsagents and newspaper sellers describing the articles in the *Review* as "malicious libels," and cautioning the newsagents against selling it, the result of which was that the newsagents were afraid to sell the *Review*. For that the proprietors and editor (Messrs. Alabaster, T. E. Gatehouse, and Kemp) brought this action, and the company set up as a defence that they had only issued the circular to protect their business and reputation. The complaint of the proprietors of the *Review*, therefore, was that the company had described the *Electrical Review* as publishing "malicious libels" on the company. It appeared, and was stated by counsel, that the controversy had arisen out of a case tried at the Bloomsbury County Court on July 19 last, in which the company sued one Jeffrey for the price of one of the belts, the price of which was £5. 5s., and of which £2. 2s. having been paid, they sued for the balance, £3. 3s. The claim was resisted, on the ground that the belts were useless; and Mr. T. E. Gatehouse, an electrician, the editor of the *Electrical Review*, was a witness for the defence, which entirely succeeded, the judgment being given against the company not only as to the balance claimed, but as to the sum paid, which they had to repay. The *Electrical Review* of July 22 last gave a full report of the case, and there was an article upon it headed, "Electropathic Belts." "The prestige of the so-called electric belts supplied by the Medical Battery Company received a heavy blow in the Bloomsbury County Court. The action was the means of completely exposing one of the grossest cases of misrepresentation of the present day, and is of special interest to electricians, because the evidence of an electrical expert was, for the first time in the history of these so-called electro-medical appliances, added to other overwhelming testimony as to their worthless nature." The article then described the "belts," which are made of ordinary webbing on which are discs of copper and zinc, and it is stated: "It is quite impossible for the belt to generate any current as worn upon the body, for the external circuit was not completed by the connecting up of the zinc and copper poles, nor were any means indicated to the defendant of doing so for himself. Assume that one of these belts is properly connected up, and that the exudations of the body act upon the metals so as to produce, by chemical action, an insignificant amount of electrical energy, does the current so produced pass through the body, and is it of any use medically? We reply, emphatically, No." Scientific reasons were given for this; and it was said "that the current generated by these belts cannot possibly influence the body." "If the much-to-be-pitied persons of both sexes who so readily fall into the snare set by the president of the British Association of Medical Electricians and of the Medical Battery Company would only reason with themselves, a few minutes' reflection ought to convince the most foolish that the idea of a poor debilitated body generating the electricity for alleviating its own sufferings is most preposterous. But what words can be found sufficiently strong to condemn the practice carried on in the Oxford-street mansion in the treatment of rupture? That it should be possible in these days of enlightenment, and in the midst of the largest city in the world, for 16,900 cases of a serious malady to have been treated by a man having such qualifications for the task as the consulting officer of the Medical Battery Company proved himself in the witness-box to possess is beyond the comprehension of any reasonable being, and if ever there was a matter demanding the immediate attention of the Public Prosecutor, the revelations made at the Bloomsbury County Court point to it. If the treatment by an unqualified man of incurable disorders which require careful and skilful medical attention is not actionable at law, the sooner some Bill is passed to make it so the better for suffering humanity. We trust that the report of this disgraceful case may be disseminated far and wide, for it will do much to enlighten the public as to the real *status* of Mr. C. B. Harness. . . . No wonder that he can spend yearly on advertisements a sum which most people would consider a princely fortune, if 16,900 cases are treated at five guineas a time—probably more in numerous cases—in between six and seven years." On August 29 another article appeared in the paper, beginning: "It is evident, from the advertisements now issued by the Medical Battery Company, that its recent action in the Bloomsbury County Court has not resulted to its advantage," etc. In consequence of these articles, in September the defendants caused a circular to be sent by a solicitor to the newspaper vendors of the metropolis stating that, having been consulted by his clients, the Medical Battery Company, the proprietors of Harness's electropathic belts, and the "institute," of 52, Oxford-street, with reference to some malicious libels published in the *Electrical Review*, and in a paper called *Science Siftings*, he gave them notice that if these or any future publications containing defamatory articles or paragraphs were sold or circulated by them, the company would hold them responsible for the exhibition of any libellous bills or placards." For that the present action was brought as representing that the *Electrical Review* was a paper in which malicious libels were habitually inserted, and that it was of a scurrilous and libellous character, the selling of which would be attended with considerable risk of civil or criminal proceedings, by reason of which it was alleged that some agents had refused to sell the paper. The defence set up was that in the *Electrical Review* were published certain articles containing accusations of fraud and dishonesty against the defendants in the conduct of their business and tending to injure them in their reputation and to diminish their profits, and that the defendants, *bonâ fide* believing that the articles were libels upon them in their business, and for the purpose of protecting their business and reputation, sent the circular complained of to the newsvendors, which the plaintiffs denied.

Mr. Finlay, Q.C., Mr. Lawson Walton, Q.C., and Mr. J. E. Bankes appeared for the plaintiffs; Sir E. Clarke, Q.C., with Mr. R. A. Germaine and Mr. G. A. Scott, were for the defendants.

In opening the case for the plaintiffs, **Mr. Finlay** declared that his clients of the *Review* contended that the belts were useless for medical purposes.

The defendants' counsel objected to this as irrelevant; the defence set up was in substance the right of self-defence, and did not raise this question of the merits of the invention That was raised in another action which had been brought.

Lord Coleridge: Possibly the trial of this action may save the trial of that. The evidence suggested is admissible, with reference to the damages. Your clients complain of the articles as calculated to injure their business and reputation in the sale of these belts; and if the belts are medically useless?

Mr. Finlay continued his address to the jury, observing that the defence set up was that the occasion was privileged, and the libel complained of justified by the *bonâ fide* belief of the defendants that the articles in the *Review* were libels on them in their business; and if he could show that they could not have had any such *bonâ fide* belief, the defence would be destroyed. Now they could not have had any such *bonâ fide* belief if they knew—as they must have known if they knew the very elements of electrical science—that the belts were medically useless. He then alluded to the former action against the *Review* by Dr. Tibbits, which, he said, was really an action by Mr. Harness, and quoted from Dr. Tibbits's book, commenting upon it to show that its statements were fallacious. He said the belts were recommended in many cases for disorders in which electrical currents even if created could be of no use. Even patients suffering from hernia or tumour were recommended to use it. The defendants had stigmatised the articles as malicious libels, and had warned the newsagents against selling the *Review*, the result of which was that the trade had been afraid to sell it. This was a serious injury to the plaintiffs; and as to the defence, that it was for the protection of the defendants' business and reputation, it was groundless.

Messrs. Hart, Timbrel, Hughes, and other newsagents were called who had received the circular, and had thereupon declined to sell the *Review* unless indemnified. One of the witnesses was from W. H Smith and Co.'s. He gave their usual weekly net sale of the paper as between 400 and 500 copies, and that, after receiving the indemnifying letter, the sale proceeded as before, and was not injured.

Lord Coleridge observed that they had called a witness from W. H. Smith and Co.'s house, probably the largest newsagents in the kingdom; that of itself would be sufficient evidence. No doubt the issue of such a circular, in the name of a solicitor, was calculated to have a serious effect.

Other witnesses were called who gave similar evidence. One of them was from Simpkin Marshall and Co., who said on receiving the circular they declined to sell the *Review* without an indemnity. Mr. Allen, of Ave Maria-lane, gave similar evidence.

Miss Reeves said that on receiving the indemnity she went on selling the *Review* as before. Asked whether it went off as well. Witness—Yes, and better.

After several more witnesses had given similar evidence,

The plaintiffs' counsel said they had many more, but thought these would be sufficient.

Mr. Francis Reeves, an electrician, stated that when the articles in the *Review* began to appear, Mr. Harness, whom he knew as a travelling railway acquaintance, spoke to him about them, "threatened all sorts of pains and penalties, and said he would drive them into the workhouse."

In cross-examination by Sir E. Clarke, witness said Mr. Harness was very angry at the articles, which he said were directed against his getting his living. The articles were rather severe upon him, certainly. The *Review* reprinted the circular, and the publishers' indemnity to the newsagents.

The plaintiffs' counsel then called Jeffery, the patient sued in the Bloomsbury County Court for the price of a belt.

Sir E. Clarke objected at once that this head of evidence would not be relevant, and was not raised by the defence. The defence was that the circular was fairly issued, and it was so, because it would not be possible to sue mere newsagents for libels in papers they sold without notice to them by way of warning (Emmens *v.* Pottle, 16 Law Reports, Q.B.D.). That was the only defence set up, and to this the evidence offered would be entirely irrelevant. (Wren *v.* Weald, 4 Law Reports, Q.B.D.).

Lord Coleridge: But here the circular was issued to all newsagents, and it is not pretended that it was intended to sue them all. Besides, the circular describes the articles in the *Review* as "malicious" libels, whereas they might be justifiable as fair criticism. He did not think, therefore, that the occasion was privileged, and, if it were, then the question would be for the jury whether it did not exceed the occasion, which would be evidence of malice.

Sir E. Clarke: Then the evidence offered would not be relevant.

Lord Coleridge: Yes, because the circular imputes to the plaintiffs that these articles were written from bad motives; and they would be entitled to show that the articles were, with reference to the nature of the case, fair.

Sir E. Clarke: Another action has been brought in which the merit of these appliances is raised.

Lord Coleridge· I know nothing about that, and it cannot affect the present.

Sir E. Clarke desired that this trial should be put off until the other came on, or that the two should be consolidated, for at present the defendants were not prepared to enter into the question.

Mr. Finlay contended that there was no ground for such an objection. The plaintiffs maintained that the circular was not sent out *bonâ fide*. The circular was sent out to all the newsagents. Was it intended to bring 500 actions against them? As to the other action, it was brought after the present and was not ready for trial, and the defendants must have known, as it was alleged in their defence, that it would be a question whether the circular was sent out *bonâ fide*, so that they could not pretend that they were taken by surprise. Under such circumstances it would be unheard of to put off this trial in the middle of it until the other was ready for trial.

Lord Coleridge said the evidence offered was relevant to an issue distinctly raised on the very face of the defence—viz., that the circular was sent out *bonâ fide*. That was disputed by the plaintiffs, and the evidence offered would be material upon it.

Sir E. Clarke then said his clients desired him to say that, not being prepared to deal with this part of the case, they would not enter into it, but would prefer to admit that the circular was a libel and leave the question of damages to the jury.

Mr. Finlay thereupon addressed the jury, in reply, on the part of the plaintiffs, and said that through the extraordinary course suddenly taken by the defendants' counsel the case would be brought to a speedy conclusion. The defendants knew very well that the whole case for the plaintiffs would be that the circular was not sent out *bonâ fide*, but to stifle the exposure of a system out of which large sums were obtained out of suffering men and women by a delusive and pretended remedy. The defendants now acknowledged that they were "not prepared to meet the case." Not prepared! Why were they "not prepared" to meet it? Because they never would be prepared to meet it. Because they knew there had been an abominable system of imposture, by which persons suffering, especially from nervous disorders, were being preyed upon by the defendants. If the defendants had dared to meet the case a great deal would have been elicited about this pretended "institute" and these pretended electrical belts. Under such circumstances he asked the jury to mark their sense of the conduct of the defendants by exemplary damages.

Sir E. Clarke then addressed the jury for the defendants, again stating that another action was pending, in which the question would be raised distinctly whether the articles in the *Review* were fair criticisms or "malicious libels." In the present action it had not been proved that the proprietors of the *Review* had sustained any damage, for it had not been proved that the circulation had fallen off. As to the other grounds of damage urged, they were not properly admissible, and involved the question which would be tried in the other action. The plaintiffs in their paper had made charges against the defendants of imposture, and the defendants in their circular had declared these charges to be malicious libels. It was justifiable for persons who were libelled in a paper, which might ruin them, to endeavour to prevent its circulation by warning newsagents against selling it.

On Wednesday morning, **Lord Coleridge** summed up the case to the jury. The action, he said, was a good deal out of the common way. The plaintiffs were the proprietors of the *Electrical Review*, a weekly periodical which appeared to have a large circulation, as the defendants had issued 500 copies of the circulars to newsagents, which was complained of. The editors of the *Review* appeared to be gentlemen of real knowledge of electrical science (which was now the subject of much study) and perfectly competent to deal with such subjects. It appeared that the company of which Mr. Harness was a member was very much taken up with the sale of "electrical belts" and even "electrical pills." He had heard of mountebanks selling marvellous pills; he did not know what electrical pills might be. The company, however, chiefly dealt in these electrical belts, which the plaintiffs had denounced as impostures, and the plaintiffs had done their best to expose what they deemed a gross system of imposture. As long as they did that honestly, and, as they believed, in the public interest, or the interest of science, they had a perfect right to do so, as it was a matter of public interest. And the company would have a right to vindicate their invention and to use strong language in so doing. But what they had done was to send round to 500 newsagents a circular denouncing the articles in the *Review* as "malicious libels." This, no doubt, was an effective, though unusual, way of preventing the circulation of the paper containing such articles. It was a circular written in the name of a solicitor, who designated the articles which had appeared as "malicious libels," and gave notice that if similar articles were published in the *Review* the company would hold the newsvendors who sold it responsible. Now, it would be for the jury to consider whether this was a libel, and, if so, what the damages should be. It had, however, been admitted by Sir E. Clarke, the counsel for the company, that the circular was libellous, imputing as it did to the plaintiffs malicious motives. The view suggested by the counsel for the plaintiffs was that the object was to suppress the publication of criticisms upon the company's remedies, and undoubtedly there was evidence to support that view. The jury had seen Sir E. Clarke virtually withdraw from any defence, and, of course, he would not have done so if he had felt that he had a case; but, of course, he could not "make bricks without straw." If the articles had been published with a malicious motive the company would have a fair right to denounce the proprietors of the *Review*, but if they were honestly written and published it would be otherwise. The plaintiffs had a perfect right to argue that these electrical belts and pills were quackery and imposture. The defendants must have known that such would be the case for the plaintiffs. The use of the electrical belts in certain classes of cases, as hernia for instance, did seem preposterous nonsense. The plaintiffs had a perfect right to say so, and to denounce a business in which sums of five, or 10, or 15 guineas were taken for such belts as remedies in cases in which they could not possibly be of any use, and especially were calculated to impose on persons subject to nervous disorders and who were ready to clutch at any apparent remedies. It was undoubtedly for the public interest that such pretences, under the guise of a spurious science and fictitious remedies, should be exposed and denounced. The defence set up for the publication of the circular was that notice was given to the newsagents, as necessary with a view to maintain actions against them. The Court of Appeal had held that a mere newsagent, a vendor of newspapers, would not be liable as publisher of libels in the papers sold, and the Court said that at all events such an action could not be maintained without notice by way of warning to the newsagent. It was on that view that the defence of the issue of the circular was based. It was said that it had been issued to the newsagents by way of notice and warning. The effect of the distribution of the circular was, however, to alarm the newsagents, who at once refused to sell the *Review* without an indemnity. The proprietors of the *Review* naturally resented this as a sort of attack and stigma on the character of the paper, representing it as merely scurrilous and maliciously libellous on account of articles purely scientific. The jury must judge as to whether the excuse for the circular was sufficient and whether it was issued *bonâ fide*, or whether the articles had been published in the interests of truth and science and for the exposure of imposture. The latter was the case for the plaintiffs, and it had not been met by any evidence on the part of the defendants, who, on the contrary, had admitted by their counsel that their circular was libellous, and that it was a question of damages. That question was entirely for the jury. Probably there had not been much actual pecuniary damage, but the character of the paper had been aspersed, and for that the proprietors had a right to reasonable damages.

Mr. Germaine desired to say, on the part of the defendants, that there was no evidence of electrical pills being sold or advertised by the company; it was only stated in counsel's opening.

Mr. Lawson Walton said his learned friend Mr. Finlay had, in his opening, stated the effect of evidence he was prepared to give of the actual sale and purchase of electrical pills.

Lord Coleridge said the jury would bear in mind what had been said on both sides, and would distinguish mere statement from evidence.

The jury, after a brief consultation, gave a verdict for the plaintiffs for £1,000.

Lord Coleridge thereupon gave judgment for that amount.

Counsel for the defendants asked for a stay of execution—the damages being excessive—to allow time for application to the Court of Appeal.

Lord Coleridge said he saw no ground for interference.

Mr. Germaine: Your Lordship said the company must have known their business would be attacked.

Lord Coleridge: I thought so, and I think so still.

Mr. Germaine said he desired to take the onus on himself.

Lord Coleridge: I cannot hear that. Counsel often are generous enough to say that.—*Times.*

THE

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ALABASTER & OTHERS v. MEDICAL BATTERY CO.

This case is better known to our readers as the *Electrical Review v.* Harness. It is the case we referred to in our leader of February 24 as pending, and as being a direct challenge. Unfortunately, our anticipation as to the evidence that would come before the Court was falsified by the action of the defendants. The ludicrous farce played last Tuesday before the Lord Chief Justice was worthier the consideration of our readers than most of the plays to be seen at a duly constituted theatre. For one of the parties in the play, however, the farce in the end threatens to partake of the nature of a tragedy. The actor who came to bestow pains and penalties upon all and sundry found himself the recipient of the evils he threatened. In other words, the *Electrical Review*, which took upon its shoulders the Herculean task of enlightening the public as to the scientific merits of electropathic belts, has been victorious; and Mr. Harness, who has made and sold these appliances, and who issued a circular to five hundred newsagents warning them against selling the *Electrical Review*, has for his labour been mulcted to the tune of a thousand pounds damages and costs. A brief history of the whole affair will not come amiss at this juncture. Our contemporary, impressed with the view—as every electrician would be—that the much-advertised and much be-puffed electropathic belts ordinarily sold by the Medical Battery Company were useless, and that the public were unjustly induced to pay long prices for appliances which could not have the effects stated, commenced a crusade against the makers and sellers of these appliances. Ultimately a criticism upon a "report" by Dr. Tibbits led to that gentleman bringing a libel action, and also led to the solicitor of the Medical Battery Company issuing a circular to newsagents. Dr. Tibbits's action resulted in the vindication of the critics, who became the plaintiffs in the libel action relating to the circular. The latter was the action tried on Tuesday and Wednesday, resulting in a verdict for the *Electrical Review*, with a thousand pounds damages. There is still another action pending, but, as the judge very properly put it, the Medical Battery Company in the still pending action are the plaintiffs, and it rests with them whether the case is ever tried or not. It is difficult to prophesy, but the general opinion is that the case will never come to trial. The proceedings in the case just over were, to say the least, peculiar. The circular issued by the defendants referred to the "malicious libels" in the paper, and therefore imputed malice to the plaintiffs. As the Lord Chief Justice said, it attacked their character, their impartiality, and their scientific knowledge. They were about to produce evidence to show the unscientific and worthless nature of the appliances sold, when the defendants suggested such evidence would be irrelevant. The judge held it to be admissible. Then the defendants said they were not at this time prepared to meet such evidence, therefore they would take a verdict against them, admit the circular to be libellous, and pay costs and damages. Thus the case came to an abrupt conclusion. The plaintiffs pleaded for exemplary damages, the defendants for nominal damages. The judge summed up, and the jury assessed the damages at a thousand pounds. The verdict is further reaching than at first sight appears. The defendants practically admit their inability to defend their method of doing business, or the utility of their apparatus. It is necessary at this time to ask those political contemporaries, by whose aid such apparatus is brought to public notice, whether any respectable paper can hereafter justify the insertion of advertisements alluding to such appliances. It is only by the connivance of newspapers that the proprietor of a quack medicine or a doubtful remedial appliance can be brought face to face with a buying public, and newspapers which lend their columns to the publication of advertisements of quack remedies are not one whit better than the proprietors of the remedies who trade upon the credulity and ignorance of the public. We admit that we have doubted the possibility of our excellent contemporary ever being able to reach the public, because a scientific paper does not usually reach the class reached by advertisements in daily and weekly papers. We were wrong. A mistaken move on the part of the Medical Battery Company led to legal investigation, with the results known. We always thought Mr. Harness would let the technical press severely alone, and no doubt he now regrets ever having moved in the matter.

In common with our contemporaries, we have received a circular, dated March 6th, 1893, from the Electropathic and Zander Institute, and signed by C. B. Harness, president, which commences, "With all the misrepresentations and the vindictive tendencies of my prejudiced critics," etc., and goes on to state the desire for "an appointed commission of unprejudiced scientific and medical men to make the fullest investigation, so as to prove or disprove, scientifically, the generation of electricity from my appliances, and medically, the remedial value attaching thereto," etc.

Mr. Harness is a clever man, but we do not accept this circular as containing a fair statement of what his critics have said, or of what they dispute. Further, we would ask Mr. Harness why any commission of competent men should sit to consider his appliances? If he wants information let him pay the price. He could have known years ago that he was walking in darkness rather than scientific light, and could have years ago obtained competent advice had he been willing to pay for it, but we doubt if there is a scientifically competent man in the universe who would now lend his aid to extricate the Medical Battery Company from the slough of despond into which it has fallen. Mr. Harness wants a commission to tell him where he is wrong, in order that he may perfect his appliances and go on making money. We should infer that any medical man who had knowledge of the remedial power of electricity would prefer to keep the knowledge of how best to apply it, for his own business purposes, rather than go on Mr. Harness's suggested commission.

As for scientific electricians coming forward to try these appliances to report thereon, to show where they are wrong and how they might with advantage be bettered, the idea is preposterous. Who is Mr. Harness, and what is the Medical Battery Company that they should command the services of scientific men for such a commission? Is Mr. Harness's sale of electropathic belts a national concern? Have the profits hitherto gone to the Treasury? Does Mr. Harness think scientific men sit on commissions because their expenses are paid? for no doubt he would be ready to pay all expenses. They do not—they have to live and provide for families; and obtaining a seat upon a national commission or upon a learned society's committee adds to their renown, and helps them in obtaining the prizes open to such men, but what renown would be increased by sitting in solemn conclave upon Harness's electropathic belts? We sincerely trust that no scientific man, be he within the folds of electricians or medical men, will come forward to support such a proposition.

But enough: the thanks of all of us are due to the proprietors of the *Electrical Review* for their labours in this matter; and we congratulate them upon having obtained a victory all along the line, and commiserate with them in the inability to get in the direct evidence relating to the electropathic belts.

WOODHOUSE AND RAWSON.

At a meeting convened by the Committee of Consultation held on Tuesday last, the report of that committee was put before the shareholders. It is dismal reading, but it corroborates all our forebodings. It shows that, from first to last, the company's balance-sheets have rather shown paper profits than real profits. England and France have at the present moment a fit of virtuousness as regards company-mongering, and we doubt very much if the directors of "Woodhouse and Rawson" will escape the mill. The Bankruptcy Court will not be satisfied with general statements where half a million of money is involved, and it is doubtful to see how this concern can escape the court. True, there are schemes of reconstruction in the air, but nothing definite is before the shareholders or the creditors. The investigation of the committee has been fairly searching, as will be seen from the report, but in our opinion the report they have given shows the necessity of legal investigation. Surely no directors are justified in carrying "doubtful items" to profit and loss account, especially when such "doubtful items" are in the shape of shares in newly-floated companies. But the report speaks for itself, and needs no comment to show the manner in which this business has been conducted, and the importance of immediate action before what assets remain are frittered away.

THE EFFECTS OF MECHANICAL STRESS ON THE ELECTRICAL RESISTANCE OF METALS.*

BY JAMES H. GRAY, M.A., B.SC., AND JAMES B. HENDERSON, B.SC., INTERNATIONAL EXHIBITION SCHOLARS, GLASGOW UNIVERSITY.

(*Communicated by Lord Kelvin, P.R.S.*)

This investigation was begun for the purpose of obtaining an easily worked method of testing the effect of any mechanical treatment on the density and specific resistance of metals.

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* Paper read before the Royal Society.

For alteration of density, copper, lead, and manganese copper wires were tested. The effect of stretching was always to diminish the density, the alteration being small however: for copper about $\frac{1}{2}$ per cent., and for lead $\frac{4}{5}$ per cent.

The effect of drawing through holes in a steel plate was somewhat greater, showing at first an increase of 2 per cent.; and, when the drawing was continued, the density began to diminish till, after drawing from diameter 2mm. to 1·3mm., it showed an increase on its original value of $\frac{9}{10}$ per cent. Several other interesting results on alteration of density were obtained.

The most important part of the investigation, however, relates to the alteration of specific resistance of copper, iron, and steel wire due to stretching; and in connection with this the authors wish particularly to emphasise the advantages to be gained from using the unit of specific resistance introduced by Weber, who always defined it in weight measure—that is, as the resistance of a length of the metal numerically equal to its density and section unity.

Taking the expression for the resistance R of a wire, of section ω, length l, and volume specific resistance σ_v, $R=\sigma_v (l/\omega)$, we have $R=\sigma_v \rho (l/\omega \rho)$ (where ρ is the density of the wire) $=\sigma_v \rho (l^2/l \omega \rho)=\sigma_v \rho (l/w) l=\sigma_w (l/w) l$, w being the weight of the length l, and σ_w the weight specific resistance of the wire. We have thus obviated the necessity of making the troublesome and uncertain measurement of the section of the wire, and only require to measure the length and the length per unit of weight, both of which can be done with great accuracy. Moreover, the weight specific resistance is found to be more nearly constant than the volume unit. Also, when only a comparison of specific resistance is required, it is not even necessary to weigh the wires, but only to measure lengths, thus making it possible to detect very small changes with great ease and accuracy.

The method used was a modification of what is known as Thomson's (Lord Kelvin's) double-bridge method ("New Electrodynamic Balance for Resistance of Short Bars or Wires," *Phil. Mag.*, fourth series, Vol. 24, 1862). The method being a zero one, the galvanometer could be made so sensitive as to be almost unstable, so that a change of 1 in 10,000 could be easily detected.

The tests showed that the maximum permanent stretching produced a permanent alteration in the weight specific resistance of copper of 1 per cent. After the maximum stretching had been produced, it was found that there was no permanent alteration of weight specific resistance due to renewed application of stress.

In the tests of steel wire no permanent stretching was obtained, but the effect of applying weight was to cause a very small permanent decrease of specific resistance, 0·06 per cent. at first, and when additional weight was applied there was found to be an increase of 0·06 per cent. These values are very small, however, compared with the temporary alteration of 1·6 per cent.

In the tests on soft-iron wire the permanent alteration due to permanent stretching was found to be $\frac{2}{5}$ per cent. After the maximum stretching had been obtained stress was again applied, and it was found, as in the copper wire, that there was no permanent alteration unless there was permanent stretching.

Hitherto the results on specific resistance have been given by all investigators on this subject, except Lord Kelvin, in volume units, but as the alteration in density is in every case very small, the results obtained in the present investigation are in very good agreement with those of former experimenters.

The conclusions arrived at are that for practical purposes any mechanical treatment, however severe, does not affect the electrical properties of the metals tested. As contrasted with this, it is interesting to note that the smallest impurity in the metal produces a greater change than the most severe mechanical treatment. For example, an impurity of $\frac{2}{5}$ per cent. lowers the electrical conductivity by 13·5 per cent., while an impurity of $\frac{4}{5}$ per cent. lowers it as much as 30 per cent.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 9.

Mr. W. H. Preece, F.R.S., President, in the chair.

The following is the list of members balloted for and elected:

Foreign Member.—D. Farman, 72, Boulevard Haussmann, Paris.

Members.—Joseph Bevan Braithwaite, 27, Austin-friars, E.C.; Arthur Hoare, Messrs. John Fleming and Co., Bombay; Herbert Talbot, The Guildhall, Nottingham.

Associates.—William Hibberdine, Winchester House, Old Broad-street, E.C.; John William Manley, Messrs. Julius Sax and Co., Smithfield Market; Edward Mann, Palace-chambers, 9, Bridge-street, Westminster; George Ralph, 1, Percy-terrace, Jesmond, Newcastle-on-Tyne.

Students.—Sidney Allingham, 11, Park Village West, Regent's Park, N.W; John Richard Jesse Bowden, 206, Croydon-road, Anerley, S.E.; Charles Brandeis, 55, Longridge-road, Earl's-court, S.W.; Gordon Paton Clark, 10, Lansdowne-road, Notting Hill, W.; Edward Herbert Cozens-Hardy, 50, Ladbroke-grove, W.; George H. Cutting, 95, Uttoxeter New-road, Derby; Henry Okazaki Fleetwood, 48, Greenwood-road, Dalston, N.E.; Herbert Henry Gresswell, 36, Marquis-road, Canonbury, N.; Mervyn J. E. O'Gorman, Central Institution, Kensington, S.W.; Henry Herbert Pickford, 458, Seven Sisters'-road, Finsbury Park, N.; Edmund A. Robins, 111, Burton-road, Brixton, S.W.; Leonard L. Robinson, "Winwood," Queen's-road, Tunbridge Wells; John Severs, 105, Sydney-street, S.W.; Robert John Jocelyn Swan, 32, Camberwell New-road, Brixton, S.W.

After the usual formal business, **Prof. S. Thompson** continued the discussion on Mr. Mordey's paper. He had been thinking about the two curves shown. They were exceedingly interesting. When a motor was running at no load and at high speed, its E.M.F. would just balance the incoming E.M.F. When the E.M.F. was not equal there was some current. If the field was over-excited, the motor would tend to become the generator. The diagrams measured how much the wattless current, or the current floating in the mains, was over the working current.

Prof. Fleming referred more especially to the electrical measurement. He showed on the table a new wattmeter with a large range, the principle of which was that the shunt coil was excited by a transformer. It had been fully described recently during the lectures at the Society of Arts, and would prove useful.

Prof. J. Hopkinson spoke of the method of testing described by Mr. Mordey as excellent, inasmuch as little power was required—only that lost in the instruments—and great accuracy was obtained. About a year ago he had experimented with a similar method, which, however, had only the first advantage, and soon after Prof. Ayrton and Dr. Sumpner carried out experiments giving both advantages. Mr. Mordey's method of testing a single machine was open to the objection that the same results were not obtained when the machine was acting as a generator and as a motor.

Mr. Kapp mentioned an example when alternators used as motors and generators agreed with Fig. 6. He referred to an installation at Cassel. There were two alternator-generators, the current was split up into two circuits, and each sub-station had an alternator between two direct-current machines and rigidly connected—a description of which, if we remember rightly, was given in Mr. Kapp's Cantor lectures. This showed that the minimum current to give a certain amount of work had been found in practice.

Mr. Harrison referred to Prof. Hopkinson's early papers, and thought in them he found the explanation of the phenomena described by Mr. Mordey. He had long thought that there was more to learn between the reactions of the armature and field for alternators. He had been experimenting with a Siemens machine, and was going to publish the full results, but would here only refer to one—the pulsation of the armature and also of the field under the conditions of his experiments. He thought this limiting of the current was an important factor where alternators were used as generators or coupled in parallel.

Mr. Swinburne sent a written communication, which was read by Mr. Kapp. As usual, the writer was not in perfect accord with Mr. Mordey, but his principal text was general and declaiming against the usual plan of considering apparatus in a central station piecemeal, instead of considering the effect as a whole. As it was, bluntly put, the buyer of a dynamo did not care about the electrical efficiency; he wanted to know its commercial efficiency.

Mr. Crompton said that Mr. Mordey had set forth the conditions to make alternators to run in parallel, but the difficult matter was in the governing question. He had examined the question with the late Mr. Willans, but did not find it easy. Alternators could easily be brought into parallel, but it would be difficult to keep them equally loaded. Mr. Willans latterly thought it would be best to put a common governor only on the steam-pipe, but it was doubtful if that would be a solution of the problem. What they wanted was a more accurately constructed governor than was at present to be found. He agreed with Mr. Swinburne that taking away the side pull of belt gave too great an efficiency to the machine. Why did not Mr. Mordey put an alternator to a Willans' engine and allow it to be tested at Willans' works? The results obtained at those works were very consistent.

Dr. Sumpner said in alternators tested as suggested by Mr. Mordey, some coils acted as dynamos and some as motors, and Dr. Hopkinson's method could therefore be used. Another advantage was that it could be applied in so many different ways. Side pull in belt could be obtained by first driving mechanically and then electrically. The method did not test actual side pull, nor the bearings — but everything else. He had lately tested a 100-h.p. motor designed by Mr. Esson.

The field magnets were fixed, the armature was a drum armature with flat coils. He had tested it in two different ways—first, with field split in two and reversed, and 12 amperes sent through one half and 8 through the other, with armature short-circuited. The same test was applied by splitting the fields into two unequal parts corresponding to Mr. Mordey's test; in each case the result was satisfactory—an efficiency of 90 per cent. He thought the curves as given by Mr. Mordey the best material to have in approaching the problem of parallel running—better than any amount of mathematics.

Mr. Bailey showed a diagram of connections to localise bad poles, as used at Paddington in the early days.

Mr. Mordey, in replying, said that engineers now put in shafts they had confidence in—those who did not could use tests—so also for bearings. Mordey machines ran for 20 minutes after belt thrown off. Prof. Thompson's objection, he thought, did not amount to much in practice. The power factor of good transformers—closed circuit—was ·75 to ·9, and the actual power represented this fraction of the apparent watts going out. Experiments had shown him the reaction in the alternator armatures was unappreciable. He hoped Prof. Fleming would make his wattmeter astatic. He hoped Dr. Hopkinson would remember many people did not understand mathematics. Mr. Swinburne's article gave him much amusement—he had found that when Mr. Swinburne said a thing *is*, he meant he thought it was.

The next meeting will be held on the 23rd inst.

COMPANIES' MEETINGS.

WOODHOUSE AND RAWSON UNITED, LIMITED.

It will be remembered that at the third ordinary general meeting of Woodhouse and Rawson United, Limited, held on December 22nd last, a committee of consultation was appointed to confer with the Directors as to the present position and future prospects of the Company, and to report the results to a subsequent assembly. The committee comprised Dr. W. S. Squire (chairman), and Messrs. Griffiths, Whateley, and Bacon, and General Fyfe, who convened a meeting, held on Tuesday, of the shareholders to consider their report. An attempt was made to exclude representatives of the Press, but this effort was unsuccessful.

Dr. Squire, who occupied the chair, remarked that one or two of the Directors had suggested that the duty of the committee should be confined to investigating the present and future position of the Company, as what had been done in the past was beyond their province. That was, however, not the view of the committee; it was only by a study of the past that it was possible to arrive at a forecast of the future. The Company in the first two years of its existence presented reports and balance-sheets showing good profits, and 15 per cent. was paid on the ordinary shares. Now, if those profits had been legitimately earned there would be a hope for the future, but if they had not, or possibly not earned at all, then the outlook for the future was far less hopeful. The committee therefore took the responsibility of going through the accounts for the first two as well as for the third year. The profit and loss accounts for the two years commenced on the credit side with gross profits so much, but there was no indication as to how those profits were arrived at, or of what they consisted. The committee had endeavoured to supply those omissions, and had succeeded in identifying certain things in the report, which was only finally settled the previous evening.

The report, which was of an historical nature, referred at first to the formation of the Company, and to the payment to the vendors, Woodhouse and Rawson, Limited, of £269,000. The vendors stated that they had been carrying on the business profitably, and as an inducement they undertook to guarantee a dividend of 15 per cent. on the ordinary shares for three years, and to deposit £75,000 as a guarantee. The latter had been done by leaving £75,000 of the purchase-money unpaid. The first annual report showed net profits amounting to £61,085, out of which dividends of 15 per cent. on the ordinary and 8 per cent. on the preference shares were paid, but there was no explanation how that profit had been arrived at. A large portion of those profits consisted of doubtful items which ought not to have been carried to profit and loss, and were certainly not legitimate trading profits. For instance, £25,000 received from the Kensington stores, £1,870 in connection with Jensen's bell, £4,050 credited as business profit on issue of shares, and £37,240 being the balance for promoting the Okonite Company. The latter was a paper profit, not one penny being received in cash. These shares were now nearly all in the possession of the Company, and were to a large extent unsaleable. The committee were of opinion that these securities should have been carried to a suspense account, and should not be considered as divisible profits until realised. The four items amounted to £68,160. Assuming that the Directors were justified in carrying the £25,000 and the share premiums to profit and loss, there remained £39,110, which, if rejected as not being legitimate profits, would reduce the net profit from £61,085 to £21,975, in which case the managing director would not be entitled to any commission. If the profits in any one year were more than sufficient to pay 15 per cent. on the ordinary shares, the managing director was to receive 25 per cent. of the excess as commission, and he had received in respect of that year's trading the sum of £13,775. Secondly, he was the liquidator of the vendor company in which he was interested, and it would benefit that company to get the guarantee fund of £75,000 out of jeopardy as soon as possible. Whilst that amount remained as a guarantee it bore no interest, but by the manner in which it had been paid it was made to come before the ordinary and preference shares, and at once began to bear interest at 5½ per cent., and had nearly doubled the debenture debt. The terms of repayment were a rebate of £12,000, £12,000 in cash, and £51,000 in debenture stock. The £12,000 rebate on the £75,000 was in the year ending July 31, 1891, placed to credit of profit and loss, and that had done more than anything to ruin the Company. The Phœnix Trust Company appeared to be the *nom de guerre* of Baron Grant, and the books showed numerous transactions between Woodhouse and Rawson, Limited, and the Trust Company, and in which they were jointly interested, one being in connection with the Epstein Company. The Epstein Accumulator Company was formed with a nominal capital of £100,000, of which £70,000 nominally were alloted—55 per cent. to Woodhouse and Rawson United, and 45 per cent. to Mr. Epstein. Each of the latter gave 10 per cent. of the shares to the Trust Company, or, say, £7,000 together. This was a paper transaction; yet after deducting the 10 per cent. and certain expenses, Woodhouse and Rawson United took credit for £31,630 net profit, which was brought into the profit and loss account as divisible profits. Another item of profit was £15,188, being profit on the issue of French and Austrian Elmore Companies, but these were on paper and practically unsaleable. Then, again, the Kidsgrove works, which had resulted in a loss of from £40,000 to £45,000, were raised in value by £2,640, and the Kensington works by £1,000. These and two other items amounted to £81,233, whilst the net profits claimed for the year only came to £51,439. The committee were of opinion that the profits during the two years were more apparent than real, and that the dividends should have been paid out of the guarantee fund. In the third year the inevitable Nemesis came and there was a great loss. The committee reported that in the very month that the shareholders were induced to assent to the repayment of the guarantee fund, money was being borrowed at from 10 to 12 per cent. to pay the dividends, and in another case the interest worked out at 22 per cent. At that time the account of the managing director with the Company was overdrawn by £20,000, but a few days before the last general meeting the Directors agreed to cancel the debt on his handing over debenture stock to the extent of £18,480. Those debentures were to be accepted at par, though the market value was not half that. The committee considered that the managing director had been hunting financial will-o'-the-wisps instead of manufacturing. The manufacturing department had been neglected, and, as a consequence, it had not been profitable, and probably from the same cause none of the branches or agencies had shown any profit. The Kidsgrove works was an unfortunate purchase, the plant being mostly antiquated, and the price paid greatly in excess of its value. The committee estimated the value of the patents and goodwill at £20,000, and had come to the conclusion that the Company was just solvent; that under an intelligent realisation there would be just enough to pay off the liabilities, including debentures and debenture stock. The main difficulty in carrying on the Company was the heavy debenture interest. The visible profit to the committee was only £11,000 a year, but that would only be sufficient to meet the debenture interest, and there would be no inducement for shareholders to subscribe fresh capital. A more hopeful proposal was that the formation of a new and independent company to lease the works and plant from the present Company, and as the assets were realised the debentures might be paid off. A small company might under those circumstances be able to make a living profit. The committee concluded by drawing attention to the small holdings in shares of some of the Directors.

The **Chairman** said that the committee were indebted to the auditors and Mr. T. Pilling for assistance in unravelling some of the accounts. Mr. Pilling, who was unfortunately unable to be present, had sent some lengthy notes, from which Dr. Squire read copious extracts, which were very similar to the report. The Chairman did not think that the Company need have made any loss. It started professedly as a manufacturing company, and had been turned into a company-mongering company. The manufacturing part had been neglected, and if it had been fostered, combined with the advantage of the large amount of money at its disposal, there was no reason why it should not have done well. He did not think it could ever have paid 15 per cent. on the ordinary shares. The Company was over-financed, and the price paid for the goodwill, patents, and other fancy items, had been so heavy that the money remaining as working capital was quite unable to cope with the liabilities. He thought that the only way in which the business could be in future carried on would be by some such scheme as that suggested in the report, and he opined that the industrial part of the business might be conducted at a moderate profit. It required a good deal of consideration before anything like a definite scheme could be propounded. Possibly the Directors might have some suggestions to make as to the future, but in the meantime it would be necessary to form some kind of scheme. General Fyfe had not signed the report, although agreeing with most of the statements in it.

A long discussion then ensued, in which General Fyfe, Messrs. Swain, and F. L. Rawson (managing director), Mr. Pope (director), and others took part.

Dr. Squire, in reference to some of the remarks made, observed that that meeting had no power to pass resolutions which would bind the Company. The proper course, as Mr. Pope explained, would be to call an adjourned general meeting, and perhaps by that time the Directors would be able to make some proposition with a view to reconstruction. In reply to Mr. Bond, the members of the committee, having finished their work, wished to be discharged from any further duties.

Mr. Bacon having made some remarks, **Mr. F. L. Rawson** observed that the Directors had been hard at work with regard to reconstruction, and a scheme would be laid before the shareholders in a month.

Mr. Bacon proposed, and **Mr. Peat** seconded, "That it be an instruction to the Board of Directors to have the report and subsequent discussion printed and circulated among the shareholders." This was unanimously adopted, and the report, etc., will be circulated by the directors.

Mr. Pope observed that a special general meeting could be convened by the Directors to follow the adjourned general meeting, and a scheme of reconstruction could then be considered.

The proceedings, after occupying near'y three hours, then came to a close with a vote of thanks to the Chairman.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

Directors: Henry Ramié Beeton, chairman; William Reginald Davies; Robert Arthur Germaine; Robert Hammond, managing director; William Francis Leese; William Page. Secretary: H. St. John Winkworth.

Report of the Directors and statement of accounts for the year ending December 31st, 1892, presented to the shareholders at the fifth ordinary general meeting of the Company, held at the Company's Central Station, Kensington, on the 2nd inst.

The revenue account shows a credit balance of £2,836. 19s, which, with the sum of £525 referred to in paragraph 6, and the balance of £291. 0s. 8d., brought forward from the previous year, makes a total of £3,652. 19s. 8d. The Directors propose to deal with this amount as follows:

Interest paid on £300,000 debentures	£1,800 0 0
In reduction of preliminary expenses	500 0 0
In reduction of suspense renewals account	100 0 0
Depreciation fund	250 0 0
Dividend of 7 per cent. on amounts paid up on £21,155 preference shares	962 5 5
Leaving a balance to be carried forward of	40 14 3
	£3,652 19 8

The Directors have the pleasure to report that during the past year the business of the Company has continued to increase; the number of lamps attached to the Company's circuits on the 1st January being the equivalent of 19,388 8-c.p. lamps, and on the 31st December 23,700. At the beginning of the year there were 373 houses connected, and at the end of the year 471. During the year another unit of plant has been laid down. This addition admits of the number of connected lamps being increased to 28,000 8-c.p. A further issue of 7 per cent. preference shares was made during the autumn, bringing the total preference capital issued up to £21,155. In addition to the profits at Kensington, the sum of £525 is guaranteed to the Company for the year 1892 in connection with the business of central-station construction which the Leeds and London Electrical Engineering Company, Limited, took over from the Company, a similar amount being guaranteed for the current year. The Directors have drawn no fees during the year, but £200 has been paid to Mr. William Page for special services. Mr. R. A. Germaine and Mr. William Page retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Theobald Bros. and Miall, the auditors of the Company, retire, and submit themselves for re-election.

Total share capital paid up	£46,795
Total loan capital borrowed	30,000
Total capital received	£76,795

Revenue Account, Year ended Dec 31, 1892.

A.—To Generation of Electricity.

Dr.		£ s. d.	£ s. d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works		2,808 12 5	
Oil, waste, water, and engine-room stores		791 5 1	
Proportion of salaries of engineers, superintendents, and officers		620 6 2	
Wages and gratuities at generating station		1,383 15 1	
Repairs and maintenance as follows:			
Buildings	£14 2 2		
Engines and boilers	327 4 6		
Dynamos, exciters, motors, etc.	68 13 1		
Other machinery, instruments and tools	249 7 11		
		659 7 8	
Cartage of ashes		72 16 6	
			6,336 2 11
B.—To Distribution of Electricity.			
Proportion of salaries of engineers		30 0 0	
Repairs and maintenance of mains of all classes		35 9 1	
Wages		30 11 10	
Repairs—transformers		8 16 8	
			104 17 7
C.—To Rents, Rates, and Taxes.			
Rents payable		195 0 0	
Rates and taxes		232 18 4	
			427 18 4
D.—To Management Expenses.			
Directors' remuneration (special)		200 0 0	
Collector's salary		104 0 0	
Stationery and printing		137 13 4	
General establishment charges		289 11 10	
Auditors of Company		21 0 0	
			752 5 2
E.—To Law and Parliamentary Charges.			
Law expenses			87 18 9
F.—To Special Charges.			
Insurance			50 4 9
Board of Trade audit			67 12 0
Sundries.			
Subscription Electrical Association			25 0 0
			7,851 19 6
To balance carried to net revenue account			2,836 19 0
			£10,688 18 6
Cr.			£ s. d.
Sale of electricity per meter at 8d. per B.T.U. (less discounts)			9,705 5 0
Rental of meters and other apparatus on consumers' premises			708 5 11
Transfer fees		£8 7 6	
Students' instruction		57 0 8	
Installation		183 3 6	
Interest and discount		26 15 11	
			275 7 7
			£10,688 18 6

General Balance-sheet, Dec. 31, 1892.

Dr. Liabilities.	£ s. d.	£ s. d.
Capital—8,322 ordinary shares of £5 each	41,610 0 0	
100 founders' shares of £5 each	500 0 0	
4,231 preference shares of £5 each, £21,155; less calls, paid since, £1,470	19,685 0 0	
		61,795 0 0
300 debentures of £100 each		30,000 0 0
Sundry creditors on open accounts		4,548 17 0
Bills payable		3,873 0 9
Net revenue account, balance at credit thereof		1,002 19 8
Depreciation fund account		250 0 0
		£101,469 17 5
Cr. Assets.		£ s. d.
Capital account—Amount expended for works		69,767 13 9
Construction business development account, as per last balance-sheet	£17,345 19 7	
Less adjustment of accounts during the year	360 5 6	
		16,985 14 1
Preliminary expenses and foundation of business account, as per last balance-sheet	4,882 8 4	
Add transfer of debenture issue expenses	153 13 2	
Add transfer of preference share issue expenses	208 16 8	
	5,244 18 2	
Less carried to net revenue	500 0 0	
		4,744 18 2
Suspense renewals account, as per last balance-sheet	400 0 0	
Less carried to net revenue	100 0 0	
		300 0 0
Stores on hand at December, 31, 1892—		
Coal	233 14 10	
Oils, waste, etc.	158 6 1	
General	16 8 6	
		408 9 5
Sundry debtors for electricity supplied to December 31, 1892		4,433 1 9
Other debtors		2,138 3 9
Cash at bankers:		
Messrs. Glyn, Mills, and Co.	1,961 12 10	
Parr's Banking Company and the Alliance Bank, Limited (Earl's Court Branch)	700 4 2	
Cash in hand	29 19 6	
		2,691 16 6
		£101,469 17 5

The fifth ordinary general meeting, under the presidency of Mr. H. Ramié Beeton, took place on the 2nd inst. at the central station, Brompton, S.W. The notice calling the gathering having been read by the Secretary,

The **Chairman**, in moving the adoption of the report and accounts, which are given above, said that all the capital expended had been spent with the greatest economy. The expenditure amounted to £11,391. 12s. 3d., which represented the construction of a large portion of the second smoke-stack, which would suffice for their completed station, comprising three times the power at present possessed. Moreover, it represented plant equal to the supply of 28,000 35-watt lamps, after providing the requisite reserve and mains equal to the accommodation, under favourable circumstances, of 40,000 35-watt lamps. With regard to the revenue operations, he mentioned that for the first time they represent continuous day and night running. It was a matter for congratulation that with the heavy extra consumption of coal and labour which they had had, their working cost amounted to the same as in 1891. For that and other reasons he thought he could promise that with the careful assistance of Mr. Page (to whose assiduity and foresight they were much indebted), by pursuing the lines they were now following, and by a limited capital expenditure on the sub-stations for securing more economical distribution, they would be able to present more satisfactory results in the future. If this assurance was warranted, he was sure that they would agree with him that their debenture and preference capital was fully secured, and that their preference shares constituted as good an investment as the market for this class of property afforded. It was, however, a matter of regret that the hopes of the ordinary shareholders remained still to be fulfilled. The fact was, that in this, as in other enterprises of a similar nature, they had difficulties to contend with, even although they carried with them compensation; but unfortunately their drawbacks were in the present, and their compensations in the future. The situation of the station was such that it could never create a nuisance to the neighbourhood, and it secured them accordingly from all possibility of difficulty and disturbance with the growth of their business in the future. The fact of having laid mains as they had done in all the thoroughfares scheduled to the area which was proper to their station. had resulted in their having at present a sparse distribution of lights, as the comparative statistics of other companies showed In short, the class of custom depending upon the character of their area, while very sure, was somewhat slow, so that there remained nothing but to continue operations patiently. He then moved the adoption of the report and accounts.

This was seconded by the **Managing Director** (Mr. R. Hammond), and was carried *nem. con.*

A dividend of 7 per cent. per annum on the preference shares was then declared, and the re-election as directors of Mr. William Page and Mr. R. A. Germaine, and the reappointment of the auditors terminated the proceedings.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

An extraordinary general meeting of the shareholders was held yesterday at Winchester House, Old Broad-street, E.C., under the presidency of Mr. C. L. W. Fitzgerald (chairman), to consider a resolution proposing a reduction of the capital of the Company.

The secretary (Mr. C. Curtoys) read the notice convening the meeting and the special resolution, which was as follows: "That the capital of the Company be reduced from £307,545, divided into 75,000 preference shares of £1 each, 75,150 ordinary shares of £1 each, and 224 850 ordinary shares of 14s. each, to £234,938, divided into 47,363 preference shares of £1 each, and 75,150 ordinary shares of £1 each, and 224,850 ordinary shares of 10s. each; and that such reduction be effected by returning the amount of £1 per share credited as paid upon each of the 27,637 issued preference shares of the Company to the holders thereof, and thereupon cancelling such shares, and by returning 2s per share to each of the holders of the 224,850 issued ordinary shares of the Company, and by writing off each of the said 224,850 ordinary shares the sum of 2s. per share as being capital unrepresented by available assets."

The **Chairman** said that the resolution the shareholders had heard meant that the Directors suggested that the £1 preference shares should be paid off at par; that 2s. per share be returned on the ordinary shares, and that off the shares of 14s. nominal value should be written a further 2s. so as to make each share 10s. nominal value. Now, in order to make matters clear, he must refer to the past history. In 1881 this Company bought certain concessions in Austria, and then formed a subsidiary company, which was named the Telephone Company of Austria, to work the concessions. Unfortunately the Directors at that period were unable to obtain capital for the Austrian Company, and the whole burden of providing money fell upon the Consolidated Telephone Company. That proved such a drain that at one time it very nearly ruined the Company. When, in 1884, he and his colleagues took the management of affairs, things had come to the pass that certain persons were agitating in Austria for the cancelling of the concessions on the ground that the business was not being properly worked. They found that the Austrian Company owed a book debt to this Company of a very large sum of money. That amount of money was eventually settled by the Austrian Company paying to this Company £34,500 5 per cent. debentures. Further, during the remaining term—that is, from 1884 down to within a year—this Company had had to support the Austrian Company, and had put a further £15,500 into the business for which they had preference shares, and in addition to that this Company held £28,355 Austrian ordinary shares. These shares were received for the sale price of the concession. The concessions purchased were for the very short period of only 10 years, and three of those years had already expired. The subscription allowed by the concessions in Austria was only a very low rate—namely, £6 a subscriber. When they examined those concessions in 1884, it was a question whether they should go on with the business or not, although they had at stake £34,500. Still, there was a somewhat obscure clause which related to the termination of the concessions. It did not say in plain English what they were to get, but the then Minister of Commerce in Austria had written a letter to the effect that in the event of the Austrian Government purchasing their telephone business, it was to be bought at the commercial value—that was, on the basis of net profits; and he had also verbally stated that if the business was not purchased, they should have a prolonged concession. That satisfied them, and they started working the business and doing everything that was asked, and satisfied the Austrian public as well as the Government. Time went on, and at last they thought it advisable to approach the Austrian Government to see what their views were—whether the business was to be purchased or the concessions renewed. The Government decided to purchase, but to their astonishment entirely repudiated the letter of the Minister of Commerce, and said their view was to purchase the business at the cost of the material they had erected. Anything more unfair could not be conceived. They had made a splendid business, and were simply to get their money back and no profit. Just to show how much the Austrian Government made out of the business during the concession, he mentioned that the Austrian Company paid about £20,000 in interest on shares, etc., and to the Austrian Government no less than £13,000. Well, he and two of his colleagues went to Vienna to try and induce the Austrian Government to alter their decision, but in spite of the Company getting the assistance of their ambassador and extremely powerful aid, they could not move the Government from their point, and at last, only one day before the end of the concession, the Company had to accept the terms offered. The bulk of that purchase-money having been paid and sent over here, had led to the Directors calling the shareholders together. They had received the £34,500 for the debentures and the bulk of the £15,550 of the preference. That would enable them to pay off the 6 per cent. preference shares of this Company and return 2s. on the ordinary shares. Owing, however, to the Austrian Government not having fulfilled their bargain with the Austrian Company—which bargain, would have made available £28,355 Austrian ordinary shares—the Company was under the necessity of asking the shareholders to write down the nominal value of their shares by 2s., making them 10s. instead of 14s. If that resolution were carried, early steps would be taken to obtain the sanction of the court, and to return the money to the shareholders without delay.

The resolution was seconded by **Sir Alexander Armstrong, K.C.B.**, and, on being put to the meeting, was unanimously adopted.

In concluding the proceedings, the **Chairman** observed that a formal meeting for confirmation of the resolution would have to be held, and that it would be duly advertised.

COMPANIES' REPORTS.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

Directors: Sydney Gedge, Esq. (chairman); General George Hutchinson, C.B., C.S.I.; R. J. Jenkins, Esq., C.E.; Frederick Newton, Esq.; the Hon. Randolph Stewart.

Report of the Directors to be presented to the shareholders at the ordinary general meeting of the Company to be held at the City Terminus Hotel, Cannon-street, London, E.C., on the 17th March at 12 noon.

The duly audited accounts of the Company for the year 1892 will be open to the inspection of the shareholders from the 14th to the 17th inst., at the offices of the Company. These accounts show a net profit of £15,456. 2s. 10d., after charging interest on the mortgage debentures and writing off £3,500 for depreciation of machinery and ship gear. Adding £21,731. 0s. 3d. brought forward from last year and deducting £808. 14s., the half-year's dividend to 30th June, 1892, paid in October, on the preference shares, there remains a disposable balance of £36,378. 9s. 1d. The Directors have added £18,545. 1s. to the reserve fund, and they propose the payment of a further half-year's dividend on the preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 5 per cent., free of income tax, on the ordinary shares, leaving a balance of £13,425. 9s. 4d. to be carried forward. Of the £30,000 B debentures created in 1891, £14,000 were paid off during the past year, and the Directors purpose to pay off immediately a further £4,000, which will reduce the amount of these debentures to £12,000. The general business of the Company in the manufacture of electric light cables, telephone cables, etc., has been satisfactory, and a considerable quantity of submarine telegraph and mining cables has been constructed for the British and foreign Governments. A cable has been manufactured and laid between the Bahamas and the Coast of Florida (U.S.A.), and a repair of one of the Western Union Telegraph Company's cables, in the vicinity of New York has been effected. It is interesting to note that no fault has been reported in any of the submarine telegraph cables laid by the Company since 1888. Numerous and important improvements have been made and are still in progress in the machinery and buildings of the North Woolwich works, including the erection of new buildings for insulating the cores of submarine cables with guttapercha. The machinery in these buildings will be driven by electric motors, and the Company will then possess the most perfect workshop of its kind in the world.

A branch establishment has been opened during the current year at Melbourne (Australia). The Directors who retire on this occasion are Mr. Sydney Gedge and Mr. R. J. Jenkins, C.E., and being eligible, they offer themselves for re-election. The meeting will appoint auditors for the ensuing year.

NEW COMPANIES REGISTERED.

London and Lancashire Electric and General Engineering Company, Limited.—Registered by J. D. Plard, 13, Sise-lane, E.C., with a capital of £20,000 in £5 shares. Object: to acquire and carry on the business of electrical engineers hitherto carried on by the London and Lancashire Electric Company, and, with a view thereto, to carry into effect an agreement expressed to be made between W. R. Pryke and W. Palmer of the one part and F. A. Franklin of the other part. Table A mainly applies.

Mazarron Electric Light Company, Limited.—Registered by Romer and Haslam, 4, Copthall-buildings, E.C., with a capital of £15.000 in 10,000 £1 ordinary and 500 £10 preference shares. Object: to acquire a concession for lighting the town of Mazarron, province of Murcia, Spain, by electricity, and to turn to account such concession. The first directors—not to be less than two nor more than five—are W. B. Kingsford and S. W. Richard. Qualification, £100. Remuneration, £50 each per annum and a percentage of the profits.

American River Electric Power Supply Company, Limited. Registered by Lyne and Holman, 5 and 6, Great Winchester-street, E.C., with a capital of £25,000 in £1 shares. Object: to adopt and carry into effect an agreement, made February 24, between the American River Syndicate, Limited, of the first part, the liquidator of the said company of the second part, and the present company of the third part, and to carry on the business of electricians and electrical engineers in all its branches. The first directors—to be not less than two nor more than seven—are Viscount Grimston, F. Retallack, O. Young, J. Taylor, and G. C. Pearson. Qualification, 100 shares. Remuneration, £300 per annum and a percentage of the profits.

Electric Anti-Corrosion Company, Limited.—Registered on the 2nd inst., with a capital of £6,000 in £10 shares, to acquire and purchase an invention, for which a provisional protection has been granted, dated March 22, 1892, and numbered 6,105-92, also French patent numbered 223,664-92, and Italian patent numbered 472-92, to enter into a certain agreement, made between J. Tellefsen and J. Bennett, to acquire any suitable trade-mark, and to exercise and turn to account any patents acquired by the Company. The subscribers are: Wm. B. Gibbs, 72, Bute Docks, Cardiff, shipowner; E. W. Pearce, Cardiff, accountant; C. Massy, 100, Bute-street, Cardiff, stockbroker; A. W. Travis, Cardiff, colliery agent; C. Ward, 54, Mount Stuart-square, Cardiff, merchant; W. F. Bell, C.E., Merthyr Vale; and E. B. Tellefsen, 101, Leadenhall-street, E.C., clerk. The rules of Table A generally apply. Registered office, 72, Bute-street, Bute Docks, Cardiff.

BUSINESS NOTES.

Dover.—The preliminaries with the Board of Trade are not yet settled.

Heaters.—M. L. Pitot, of 39, Rue de Chateaudun, makes some very artistic forms of heaters on the Bundy system.

Bury.—A technical laboratory is to be erected at Bury in connection with the technical schools, at a cost of £1,300.

West India and Panama Telegraph Company.—The receipts for the half-month ended February 28 were £2,443, against £2,635

Cuba Submarine Telegraph Company.—The receipts for the month of February were £57 more than for the corresponding period.

Eastern Telegraph Company.—The receipts for the month of February were £55,281, as against £58,284 for the corresponding period.

Craig-y-nos.—Electrical engineers are engaged in laying down a supplementary electric light installation at Craig-y-nos, which is estimated to cost £250.

Tiverton.—At the meeting of the Tiverton Guardians the tender of Mr. R. Ellis, Tiverton, to carry electrical communication over the house for £6 was accepted.

Oxford Streets.—The Oxford City Council are anxious to have a statement of the actual cost to the city of the works carried out by the electric light company.

Brazilian Submarine Telegraph.—The Directors have declared an interim dividend of 3s. per share for the quarter ended December 31, 1892, payable on the 25th inst.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,816.

Great Northern Telegraph Company.—The receipts of this Company for February were £20,400, making an aggregate of £41,200, against £40,800 in 1892, and £41,600 in 1891.

Andrews and Preece, Limited.—At the annual meeting of shareholders of Andrews and Preece, Limited, held on Tuesday at the Company's offices, a dividend of 5 per cent. was declared for the year ending December 31, 1892.

Oxford Municipal Buildings.—A sum of £4,300 has been set aside for fitting the Oxford municipal buildings to be erected at once, and part of this sum provides for electric light fittings.

Sale.—Six Elieson electric cars, with timber shed, dynamos, tools, and fittings, were put up to auction on Wednesday at the electric tramcar station, Plashet Hall Works, Romford-road, by Messrs. Wheatley Kirk, Price, and Goulty.

Camberwell.—The General Purposes Committee of the Vestry of Camberwell have appointed Mr. E. Manville, of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, to advise them how best to introduce electrical power into Camberwell.

Fleetwood.—Now that the Fleetwood Gas Committee find that the local authorities are in earnest on the electric light question, they are talking about a reduction in the price of gas. It will bear it, for the present price is 4s. 2d. a thousand. The electric light will be well appreciated.

City and South London Railway Company.—The receipts for the week ending March 5 were £929 against £893 for the corresponding period of last year, or an increase of £36. The total receipts for 1893 show an increase of £1,040 over those for the corresponding period of 1892.

Rottingdean Electric Railway.—The Board of Trade take objection to Mr. Volk's project to connect Brighton and Rottingdean by an electric railway running along the seashore, and on the motion for the second reading of the Bill, by which powers are asked for the new line, Mr. Mundella will move its rejection.

Telegraphic Communication with the Pamirs.—The Press Association understands that negotiations are being conducted by the Chinese Government for bringing the Pamirs into direct telegraphic communication with Pekin, and that the route of the lines will affect Great Britain. Possibly Northern India may have a station on the system.

Barrow.—The Barrow Town Council have resolved to appoint a committee to take into consideration the advisability of applying for a provisional order for a system of electric lighting in the borough. Mr. Councillor Smith moved the resolution in a long speech, and after discussion it was agreed to refer the matter to the Gas and Water Committee.

Burton.—The Burton Electric Light Committee at the Town Council meeting last week, recommended the acceptance of the tender sent in by Mr H. Slater, of Ashby, for the electric light buildings, the amount being £2,700 odd, while the estimate of Messrs. Hill and Smith, of Brierley Hill, was advised for the iron roofing at £720. 19s. 5d. This was agreed to.

Weston-super-Mare. — The proposal to establish a refuse destructor in Weston-super-Mare may be the first step towards providing the town with electric light. The example of Scarborough in introducing the electric light seems to be favourably regarded in Weston, and as the provisional order expires in June this year it is evidently time something was done in this town.

New Swindon.—A letter was read from the clerk of the Vestry of St. Pancras, stating that in consequence of the adoption by that authority of the electric light, the Vestry had 200 lamp columns for disposal. He would be glad to know if this Board had any requirement for the same. The Chairman, however, laughingly mentioned they should be in the same condition shortly.

Ilford.—A report has been received by the Ilford Local Board from the engineer of the Brush Company on the lighting of Ilford. He recommended that they should start with two sets of engines and dynamos, and gave figures to show that electric light might be provided at lower cost than gas. There was also a tender from the Brush Company. The subject was referred to the Lighting Committee.

Coventry.—The General Works Committee of the Coventry Town Council reported at last meeting that they had considered the draft of proposed agreement with Mr. Graff Baker with respect to electrical equipment of the tramways, and agreed upon modifications thereof. It was decided to leave the negotiations in the hands of the committee, but without power to finally conclude the agreement.

Direct Spanish Telegraph Company.—The Board have decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 4 per cent. per annum (free of income tax) upon the ordinary shares, both for the half-year ended December 31 last. The receipts for the month of February were £57 less than for the corresponding period.

Kingston.—At the meeting of the Kingston Town Council, last Thursday, it was agreed, on the recommendation of the Electric Committee, to accept the tender of Messrs Siemens Bros. and Co. for the supply and laying down of electricity plant and mains for the borough, at a first cost of £11,800. A portion of the Downhall meadows will be used for a central station, and the committee was authorised to procure the necessary plans.

Extension at Nelson.—We are pleased to note that the electric installation at the enterprising town of Nelson already requires extension. Letters to the Gas Committee were read from Messrs. Wilkinson and Co., and the secretary of the Tradesmen's Associations as to the supply of electric light, and it was resolved that the town clerk be instructed to make application to the Local Government Board for the balance (£6,080) of borrowing powers for electric lighting purposes, for which an enquiry has already been held.

North Staffordshire Institute.—At the meeting of the North Staffordshire Institute of Mining and Mechanical Engineers, an exhibition of objects connected with mining was on view. Messrs. John Davis and Son, All Saints' Works, Derby, illustrated their method of attaching telephones to existing signal wires, electric blasting apparatus, both high and low-tension systems. They also showed Davis's self-timing anemometer in aluminium, various electric lighting instruments for mining fittings, electric signal bells, telephones, switches, keys, cells, insulators, and other fittings.

Bray.—At the monthly meeting of the Bray Township Commissioners, a letter was read from the Board of Trade stating that the question of preparation of regulations for public safety, applicable to an installation of electric lighting similar to that of Bray, was now under consideration. Mr. J. D. A. Norris wrote, stating that any matters concerning Messrs. Gordon's contract, of which the Commissioners required information, would be attended to by him. Consideration of several matters in reference to the electric lighting of the township was postponed pending final completion of contract.

Reading Telephone.—The trunk telephone line between London and Reading will be completed within a fortnight, and it is proposed to connect Windsor therewith (through Slough) and also Maidenhead. It appears that a yearly subscription of eight guineas will be charged for connection within a radius of one mile of the local exchange. Through communication with the London and provincial exchanges may be obtained upon payment of the small fee of 3d. for three minutes' conversation with London. Mr. W. Sevenoakes is the local agent of the National Telephone Company, Limited.

Glasgow.—The lamps used for the electric lighting in Glasgow carry the light at a height of about 18ft. above the pavement. The lanterns have the form of an inverted octagonal pyramid filled in with corrugated glass, similarly to those used in London. They are placed at distances of from 80 to 100 yards apart, and these distances are so arranged that there are always two lamps at diagonally opposite corners where streets cross. The gas lamps are now turned out in the streets having the electric light.

Southampton Pavilion.—At the Southampton Town Council meeting last week Mr. Bone, in moving the adoption of the Works Committee's report, stating with respect to the culvert for electric mains, that it was felt desirable that it should be made large enough to carry another main, in case of necessity, for lighting the quay by means of electricity. The clock had been placed in position at the Royal Pier, and he was told that it was keeping satisfactory time, and showed out beautifully at night when lighted with the electric light. It was a great advantage to the neighbourhood. The report was adopted.

Chicago Auditorium.—The Siemens and Halske Company of Chicago, an American branch of the Berlin firm, has taken a contract for what is claimed to be the largest isolated electric plant in existence, that for the auditorium building in Chicago, and its new annexe across the street, Congress Hall. The original auditorium plant was of Edison manufacture, and this will be removed and the Siemens and Halske plant substituted. The power station will be of sufficient capacity to furnish current for 25,000 incandescent and 200 arc lamps, besides operating the passenger and freight elevators in both buildings.

Electric Lighting Charges at Blackpool.—At the Blackpool Town Council on Tuesday, the minutes of the Electric Lighting Committee, fixing the charges to be made for the current and the discount to be allowed on account, were referred back, the amendment being moved by Alderman Bickerstaffe. The committee proposed, Councillor Buckley said, that the small consumers should be allowed no discount, but that 25 per cent. be allowed on bills of £100. Councillor Sergenson said all the accounts were subject to a discount *pro rata*. It was also stated that in 12 months the illuminant would be supplied at the same price as gas.

Tunbridge Wells.—A meeting of the Town Council was held on Wednesday last week, when the chief topic of discussion was the proposal to adopt the electric light in the borough. Alderman Clifford moved the confirmation of Mr. Preece's report. Councillor Finch seconded, and the motion was supported by Councillors Wood, Wilmot, and others. Alderman Cronk moved an amendment in favour of deferring the subject for a couple of years. An animated debate took place, and on a show of hands being subsequently taken 14 voted for the amendment and 14 for the original motion. By the Mayor's casting vote the amendment was carried.

Southampton Docks.—It has now been decided to light the whole of Southampton Docks with electricity, whilst the cranes will be worked by hydraulic power. The plant will be ready for the arrival of the first of the new line of steamers from America. The outside lights are to be the newest type of arc lamps suspended on poles about 55ft. high, whilst inside the sheds incandescent lamps will be used. The generating plant is on the premises. Overhead cables of bare copper are used, so arranged that the breaking down of one or two will not affect the light. The new baggage station and refrigerator are also to be similarly lighted.

Cheap Electricity.—Lecturing to the Architectural Section of Glasgow Philosophical Institution on Monday night, Mr. T. C. Fulton, electrical engineer, Glasgow, said of all prime movers for generating electricity a water turbine, if there was a convenient and plentiful supply of water, was the most inexpensive and economical. Though perhaps the actual outlay would exceed that paid for a similar amount of light obtained directly from gas, yet when one considered that electric light was safer, healthier, and steadier, and that it did not consume any oxygen nor vitiate the atmosphere, it would be found in the long run to be much more economical.

Newark.—The Electric Lighting Committee reported to the last meeting of the Newark Sanitary Authority that Mr. R. White and Mr. Councillor Norledge had attended before them, representing persons who were desirous of introducing the electric light into Newark, and asking that the Council facilitate them in the acquirement of a provisional order for the purpose. It was resolved that the meeting be adjourned until Mr. Norledge had prepared a full statement of the terms on which he would ask the consent of the Council to the application. In answer to Mr. Morris, the Mayor said there had been no further meeting, and the matter remained in abeyance until Mr. Norledge had prepared his report.

Telephones for Manchester Tramps.—At the meeting of the Manchester Board of Guardians last week, the clerk intimated that in consequence of complaints made by tramps at the Salford Workhouse that they had been refused admission to the Manchester wards, a conference had taken place between representatives of both Boards of Guardians, and satisfactory explanations had been given. The outcome of the conference was a suggestion that the casual wards of Manchester and Salford be put in telephonic communication, so that if one set were full vagrants could be sent to the other, and, further, that the Chorlton Board of Guardians and the Prestwich Board of Guardians be asked to allow their wards to be also put in telephonic communication with those of Manchester and Salford. The resolution was carried.

Glasgow.—At the monthly meeting of the Glasgow Town Council, Mr. W. F. Anderson asked what arrangements were being made for the introduction of the electric light into Argyle-street. He was informed that, in consequence of the construction of sewers, it would probably be 18 months or two years before the electric light could be there introduced. If that was likely to be the case, he thought the frontagers should have information, as otherwise they might be putting up fittings which might be found obsolete at the end of 18 months. Mr. Ure said that the convener of the Statute Labour Committee might be able to give some definite information on the subject. At the same time he could assure the Council and Mr. Anderson that as soon as it was possible the wires would be laid, and that there would be no delay on the part of the Electric Lighting Committee.

Commercial Cable Company.—The Directors have issued their report for the year 1892, in anticipation of the meeting to be held on the 20th inst , in which it is stated that the gross earnings for that period amounted to 1,890,377dol., and the net revenue to 1,099,587dol., the latter showing an increase of 14,263dol. as compared with those for 1891. Quarterly dividends of 1¾ per cent. each have been paid, absorbing 540,120dol., while debenture bonds to the amount of 600,000dol. were redeemed on January 15 last, reducing the total amount outstanding to £80,000. In order to make provision for the laying down of a third cable, it has been decided to offer to the shareholders for subscription at par 19,290 shares, out of 22,840 shares now unissued. Each shareholder will thus be entitled to subscribe for one share for every four shares held. The directors have decided to forthwith lay a third cable between Nova Scotia and Ireland.

Cardiff.—In a recent letter to the Cardiff paper, Mr. Massey stated that secondary batteries were being charged by alternating currents "every day." In a laboratory, possibly ; but in saying this, Mr. Massey was speaking a little beyond the book. Mr. S. F. Walker comes down heavily on this boast, saying, "With the statement that its possibility in a practical sense has been long known, I distinctly join issue. More than that, it was only about 18 months since, when to their intense surprise the advocates of the high-tension alternating-current system with transformers found that they could not earn a dividend, while the low-tension direct-current systems, in which the slack hours were used for charging accumulators, could, that the question of attempting to charge accumulators with alternate currents arose. If the problem has been solved in a thoroughly practical manner, I shall be very pleased indeed to hear of it."

Toxteth (Liverpool).—On Wednesday, 1st inst., at the Law Association Rooms, Liverpool, Major Cardew, Board of Trade inspector, held a private enquiry relating to the dispute between the Toxteth Park Local Board and the Liverpool Electric Supply Committee as to the specifications and conditions upon which the company shall lay mains, etc., for supplying electric light to the Board's district. The Board and the company had failed to agree as to the conditions to be observed, and the authority of the Board of Trade was invoked in order to settle the disputed points. The Board was represented by Mr. Cornett (clerk), Colonel Whitney (chairman of the General Purposes Committee), and Mr. W. H. Williams (chairman of the Health Committee), while the Electric Committee was represented by Mr. Radcliffe (solicitor) and Mr. Holmes (engineer). The inspector heard evidence and arguments as to the details in dispute, and will no doubt report to the Board of Trade in due course.

Hand-Power Morticing Machine.—A new hand-power morticing machine has been brought out by Messrs. John Wild and Co., of Oldham. The power applied to the machine handle is transmitted direct to the chisel, and has not to pass through a number of joints, pins, and levers as in most other designs, therefore by this construction more useful work can be done by the power applied than by any other. The machine is suitable for working either hard or soft wood, and is therefore useful for cabinetmakers, joiners, wheelwrights, and other workers in wood. The frame is all in one casting, thus giving the machine great rigidity and strength, both of which are not only desirable but absolutely necessary for the execution of good and accurate work. Each machine is complete with boring apparatus, six self-coring chisels, one core-driver, and spanner. The leading features of this machine are its simplicity, strength, accessibility to all working parts, no joints or pins, large wearing surface, good finish and cheapness.

Salford.—At the Salford Town Council meeting last week, Mr. Alderman Dickins enquired whether a sufficient number of promises had been received from residents in the neigbourhood which was to be lighted by electricity to warrant the expenditure of £50,000. Mr. Holland, chairman of the Gas Committee, replied that sufficient promises had been received to justify them in proceeding with an installation which would cost £30,000. Since that time the committee had found that they could not light one part of Chapel-street by electricity and leave the other part in the dark. A sum would also be required to cover "incidentals." In reply to the Mayor, Mr. Holland said he feared the electric light would not be ready for next winter. Mr. Mansfield wished to know it the National Telephone Company intended to oppose the Corporation Bill. He understood that the electric lighting current had been found to interfere with the telephone, and that on this ground opposition would be offered. The Town Clerk replied in the negative.

Windsor.—The following is the solution of the electric lighting difficulties at Windsor suggested by a correspondent of the local paper: "Let the Corporation approach the company with a view to taking the provisional order, which could easily be transferred; offer them a good price for their plant and something for compensation, and run the installation themselves for the benefit of the whole town. The gas company and their friends would exclaim against this, and talk of spoliation. The Corporation might dispose of them without much sacrifice, but the Corporation might use gas-engines. Then, assuming this idea to be realised, the gas company by supplying the engines could keep up their output and their dividends; everyone could have the electric light at a moderate price; small machinery could be driven during the day time, the town would have gained an improvement and a new attraction, and the parties might shake hands and be happy all round. Proper and even generous terms should be given to the electric company," adds the writer; "is 'Barkis' (the company) willing?"

Fire Alarms at Derby.—A new system of fire alarm of a somewhat elaborate character was put into operation at Derby on the 23rd ult. Boxes are let into the walls at 17 points in various quarters of the town and suburbs, and from each there is an electric communication with the central fire station in Jury-street. Any person can give the alarm by breaking the glass and pressing a button. The fire station is in telephonic communication with the Town Hall and police station, also with the houses of the chief turncock and of the electrical engineer who has designed and installed the system, Mr. S. Rowbottom. At each street box there is an arrangement by which the officer in charge of the brigade may attach a telephone on his arrival, and thus communicate with the fire station. Over 17 miles of wire have been used, but the cost is only about £200, and Mr. Rowbottom undertakes to keep the system in order for eight years. The Mayor (Mr. W. H. Marsden) and the members of the Fire Brigade Sub-Committee attended at the central station, when the system was inaugurated, and tested the apparatus.

Cost of Electricity.—Messrs. Laing, Wharton, and Down writing to the *Manchester Guardian* say: "In the case of gas, the minimum cost of gas in Manchester is 2s. 6d. per thousand feet. The cost of electric lighting, while it may probably average 4s. to 4s. 6d. per 16-c.p. light, will vary very much, being far less expense to those (whether having ten or a thousand lamps) who use artificial light for many hours each day. Thus in an office where the hours per annum for using artificial light do not exceed five hundred the cost will be comparatively high as compared with gas; but in warehouses, packing-rooms, and cellars, hotels, restaurants, shops, etc., where the hours are many and sum up to, say, twelve hundred or more per annum, the cost will be little above that of gas, say, as 3s. to 2s. 6d., with all the counterbalancing advantages of safety, absence of heat, cleanliness, handiness, etc. Besides which, it is possible and probable that as the present rates are as high as they well can be—*i.e.*, at the limit allowed by the Board of Trade—the cost may, possibly at an early date, be considerably reduced to the consumers if the light is generally adopted."

Derby.—An enquiry was held at Derby last week by Mr. F. E. Tulloch, A.M.I.C.E., one of the inspectors of the Local Government Board, respecting the application of the Corporation of Derby to borrow £50,600 for purposes of electric lighting, street improvement, new streets, and other purposes. There were present—the Mayor (Mr. W. H. Marsden), Alderman Sowter, Alderman Newbold, Councillors Riley, Harrison, and Bottomley, the Town Clerk (Mr. H. F. Gadsby), Borough Surveyor (Mr. R. J. Harrison), Borough Accountant (Mr. W. Cooper), Mr. Harris (Bramwell and Harris), and others. The arrangements for putting down the installation of the electric light, for which a loan of £30,000 is asked, were explained by Mr. Harris. The works are now in progress in Silk Mill-lane. It was stated that the Corporation now paid £4,000 a year for public lighting, including £780 in the area to which it was proposed to apply the electric light. They will thus start practically with a revenue of £780 a year, and they hope eventually to make a profit by supplying private consumers. The estimated annual cost of the electric lighting is £2,767, exclusive of the amount necessary to repay the loan. At the conclusion of the enquiry the inspector visited the station.

Liability of Electric Lighting Companies.—On the 3rd inst., at the Brompton County Court, before Judge Stonor and a jury, a case was decided on the Employers' Liability Act and Lord Campbell's Act. The case was Annie Lang *v.* the House-to-House Electric Lighting Company, Limited, the plaintiff appearing as the widow of Thomas Piercy Lang, for the benefit of herself and two infant children. It appeared that on November 9 last, Lang, who was a workman in the employment of the defendants, met his death while engaged in hauling electric wires into position after they had been slackened in order to make a connection between the main in the street and a private house. A very small portion of the indiarubber and other insulating covering of the wire was rubbed, or broken off, and his fingers coming into contact with the "live" wire, which was under high tension of 2,000 volts, he fell back and died almost instantaneously from the shock. The jury found there was negligence on the part of the defendants or their servants by reason of a dangerous system of working, and that such negligence caused the accident, but that the deceased was guilty of contributory negligence by not using the gloves provided by the company. The learned judge therefore entered judgment for the defendants without costs. In the event of a verdict for the plaintiff, the damages had been agreed at £195. Mr. Lynden Bell was counsel for the plaintiff, and Mr. Ruegg for the defendants.

Wrexham.—The report of the Lighting Committee presented to the Wrexham Town Council last week stated that a letter from Messrs. Lewis and Son, referred to the committee by the Council, was read, which stated that the Wrexham and District Electric Supply Company, Limited, were now prepared to enter into negotiations for the sale of the company's undertaking to the Corporation. It appeared that the company had abandoned that part of their original scheme which involved the occupation of the Wilderness Mill, and obtaining water from the River Alyn; and that they had resolved to confide their operations at present within the borough, and, to that end, had negotiated terms and obtained specifications for the construction of a central station, with generating machinery, and for laying down mains within their compulsory area for a supply of 2,000 lamps; and to maintain and work the system for two years, the works and means of supply to be completed within six months from the signing of the contracts. The company would be happy to confer with a committee or deputation of the Council, and to explain all details, plans, and figures connected with the undertaking, and afterwards to state the terms upon which they would transfer all their powers and interests to the Council. It was recommended that the Council avail themselves of the suggested explanation by inviting the attendance of the directors and their engineer (if the company thought fit) at an early date, to meet the Lighting Committee, to confer with a view to more detailed information being laid before the Council. This report was adopted.

New Telegraph Steamer.—The new telegraph steamer "Norseman," built and engined at Leith by Messrs. Ramage and Ferguson, Limited, for the Western and Brazilian Telegraph Company, Limited, London, has left the Firth of Forth to take up her station on the East Coast of South America, *viâ* London, where a large consignment of cable is to be taken on board. This fine steamer, which is probably one of the most completely equipped vessels of her class in existence, has been specially designed for laying and picking up ocean cables, and within moderate dimensions combines great power with the maximum accommodation for electric appliances, along with most commodious quarters for the staff on board. Her principal dimensions are: Length, B.P., 226ft.; breadth, moulded, 31ft.; and depth, moulded, 23½ft.; while the propelling power is supplied by triple-expansion engines, having cylinders 25in., 40in., and 62in. diameter, by 39in. stroke, supplied with steam from steel boilers working up to 165lb. per square inch, with which a very high rate of steam is attained. The cable-laying machinery, supplied by Messrs. King, Brown, and Co., Edinburgh, is on the fore deck, and abaft are the cable-tanks, which are capable of holding many hundred miles of telegraph cable. All the very latest inventions and appliances have been supplied, including electric light, steam steering gear, steam windlass, steam winches, etc.; and the cabins, with their fittings, have all been specially arranged for a South American climate. The "Norseman" takes the place on the coast of the company's other vessel of the same name, and is commanded by Captain Lacy.

Country Installations.—We understand that Messrs. Woodhouse and Rawson United, Limited, have recently carried out the following installations: Through their Dublin agency the premises of Mr. James Fox, College Green and Grafton-street; Messrs. the Indian Tea Company, Grafton-street; Mr. W. Sexton, Grafton-street; Mr. Lucas's hairdressing-rooms, Suffolk-street; Mr. Humphrey, Dame-street; Mr. Diamond, Parliament-street; Mr. Mooney's chambers, Fleet-street, Dublin; they are also reorganising and greatly extending the lighting of the Stephen's Green Club (originally put up by a local firm), and are at present engaged on various alterations and additions to the Kildare Club installation. Through their Bradford branch they have fitted the following: the borough surveyor's office, Huddersfield; F. C. Foster, Esq., Queensbury; H. A. Foster, Esq., Queensbury; John Foster, Esq., Egton; the Harrogate Hydropathic Establishment; G. A. Carr and Co., Grimsby; J. H. Haggis, Esq., Oakworth; Joseph Nicholson, Esq., Leeds, Manfield and Sons, Hull; C. F. Tetley, Esq., Leeds; Yorkshire House-to-House, Leeds, wiring of central station; E. Holmes, Esq, Bradford; the warehouses of Messrs. Heyman and Alexander, Bradford; the offices of Messrs. Neill and Broadbent, Bradford; the Low Moor Iron Company's furnaces installation; and through their London offices: Messrs. Lenders and Co.; Messrs. Angier Bros.; Messrs. Randall and Co.; Messrs. Holzapfels Composition Company; premises of the *Yachtsman*; Major-General Fremantle; W B.

Buer, Esq.; electric apparatus for pumping station, Crossness, for the London County Council. In addition to these they have also in hand installations for large country mansions near Manchester and Glasgow.

Maidstone.—At the meeting of the Maidstone Local Board last week, the Electric Light Committee recommended the payment to Mr. Hawtayne (consulting electrical engineer) the sum of £26. 5s. beyond the 50 guineas for preparing his scheme, for extra services and attendances at the committee meetings. Alderman Long, in moving the adoption of the committee's report, said that the arrangement with Mr. Hawtayne was that he was to have 50 guineas for drawing up his report; and he believed that he attended five or six times afterwards, for which he made this extra charge. The Mayor (replying to Alderman Ellis) said there was no other expense attached to the scheme excepting that for the provisional order. Mr. White moved that they pay only the 50 guineas. He thoroughly understood that that was to be the total remuneration to Mr. Hawtayne. Mr. Burnard said he understood that the 50 guineas was for the maps and estimates, and he thought that they ought to accept the committee's recommendation. Mr. Cox seconded Mr. White's motion. He distinctly remembered that Mr. Hawtayne was engaged to make plans for the whole of the borough for 50 guineas, and report thereon. Now if a professional gentleman undertook to make a plan and estimate, he failed to see how he could expect to do it by one or two visits. He would like to see the plans for the whole of the borough. He strongly protested. The Mayor expressed surprise that Mr. Cox should think that 50 guineas was too much for the work agreed upon. This £26 which Mr. Hawtayne asked in addition was for attending there on several occasions when he was asked to come down and give them advice. It was not usual, he added, for professional men to give advice gratis, and he thought it would be only fair to pay this amount. After further discussion, on the motion of Mr. Cox, it was agreed to refer the matter to the next meeting to have the minute of Mr. Hawtayne's engagement read.

Rotherham.—The chairman of the Rotherham Gas Committee, speaking at the Town Council meeting last week, said that as to electric lighting the Council could not do anything for 12 months at least. They would have to apply for a provisional order in November or December, and the possibility was that they might be kept waiting eight or nine months beyond that time. Later in the meeting Mr. Hirst moved the following resolution: "That a sub-committee, consisting of the Mayor, ex-Mayor, and Councillors Stoddart and Walker, be appointed to enquire into and report to the Council upon the cost of an electric lighting plant, the most suitable site for same, the probable revenue and any other information likely to assist the Council in deciding whether it is advisable to establish the electric light in the borough." At considerable length he went into the whole subject, submitting that the present was a favourable time for the introduction of electric lighting. Details of an installation suitable for the borough were given. The cost, roughly speaking, for boilers, engines, dynamos, exciters, switchboards, and condensing plant was about £7,500. Transformers were put down at £750, and underground mains might mean £3,000. There was also the cost of building, say, £2,000. Altogether the outlay might mean £15,000. He calculated that after all expenses there would be a profit of £2,000, whilst the Council would have provided a light far superior to gas. Mr. Gummer seconded the motion. On the suggestion of Mr. Mason, the resolution was amended to include the obtaining of information as to the probable number of lights likely to be taken by consumers. Mr. Stoddart had no objection to electric lighting, but he thought the resolution was forestalling the chairman and members of the Gas Committee, who had instructed their engineer to get out particulars as to cost, etc., of electric lighting. He regarded Mr. Hirst's figures as open to considerable extension, and would not be surprised if the sum for such a scheme did not amount to £24,000 or £25,000. The question of remuneration for the engineer was also referred to. In the end the proposition was passed, and the names of Mr. Winter and Mr. Hickmott were added to the committee.

Caledonian Railway.—An interesting statistical statement illustrative of the development of the telegraph department of the Caledonian Railway Company has been prepared. It shows that in January of the present year the mileage of telegraphic wire on the Caledonian Railway was 10,063 miles; in 1870 the mileage was only 3,597 miles. In January last the number of telegraph block signalling, tablet, telephone, and other electrical machines in stations, signal-boxes, etc., was 6,076; in 1870 there were only 412. It will thus be seen that no less than 15 times the quantity of appliances required 20 years ago are now employed in the signalling and working of trains and traffic. The bulk of the increase has been brought about by the introduction of block, train tablet, and other appliances, to ensure safety in the working of trains and in the conveyance of passengers. There is no portion of the Caledonian passenger line on which an approved form of block signalling is not provided. The extent of the electrical signalling arrangements will be more apparent when it is pointed out that the number of machines employed is three times as great as the number used by the Post Office for the public telegraph service throughout the whole of Scotland. The number of battery cells provided to work the railway electrical appliances is 39,700; in 1870, 2,884 were sufficient. In 1892 the number of business telegrams forwarded from stations on the Company's wires was 1,106,278. These messages averaged about 20 words each, representing, at the public rate of ½d. per word, the sum of £46,120. Telephonic messages, which are not included, would bring the total up to £50,000. Train departures signalled from station to station and signal-box to signal-box are not included, but number many millions. At the Central Station, Glasgow, the Company manufactures its own light, and the amount required in the block, including the station, hotel, and archways, is equal to a gas consumption of between 30 and 40 million cubic feet per annum, or as much as would be required to light a residential population of over 30,000. Electric light has been substituted for every gas-jet in the block, from the lowest cellar to the clock tower. The Grangemouth Docks of the Caledonian Company are also lighted by the same illuminant. The telegraph department of the Company are now laying down plant for electrically lighting the new Princes-street Station, Edinburgh.

Printing by Electricity.—The printing department of the *Dundee Advertiser* and *Evening Telegraph* has been equipped with the electric motor. Saturday's issue of the evening paper was successfully printed by electric power, being the first newspaper in Scotland to be produced in this way. The *Advertiser* of Monday would also have been printed by electricity, but the Dundee Gas Commissioners' electric installation is not yet in complete working order, and cannot supply electricity in the early hours of the morning, when the journal goes to press. Already a Birmingham newspaper is provided with electric motors, and in a new printing establishment now being equipped for a London evening newspaper these motors are to be chiefly used. "In this office," says the *Dundee Advertiser*, "steam, water, and gas engines have been successively employed, and in experimenting with electricity we are in a position to judge the relative merits of this new source of power. The electric motor was made by Messrs. Mather and Platt, Manchester, and it has been fitted by Messrs. Lowdon Brothers, electrical engineers, Dundee. It is of 22-h.p., and on the electric current being turned on it revolves at a speed of 900 revolutions per minute. In size it resembles a domestic sewing machine. It occupies very little space—not the tenth of the room occupied by a gas-engine—and in point of convenience and absence of smell, heat, dirt, or noise it is unequalled. Electricity is already largely employed in aid of journalism. The electric telegraph enables us to maintain instant communication between the *Dundee Advertiser* office in Bank-street, Dundee, and our office in Fleet-street, London. The electric telephone admits of conversations being conducted between the head office and our branch offices in Perth, Arbroath, Montrose, Forfar, Aberdeen, and elsewhere. The electric light now sweetens and illuminates with almost the brightness of sunlight the rooms where the staff on night duty are engaged in putting together the news of the day. And now the electric motor is available to drive the large rotary printing-presses which, at enormous speed, transform webs of white paper into thousands and thousands of sheets containing news from all the corners of the earth. To none does electricity render more service than to the journalist." A leading article is also devoted to the convenience of electric power. With such notices, there should be a good field for electric motors in Dundee.

Cardiff.—The *Western Mail* of the 8th inst. gives a sketch of the proposed central station for Cardiff. It says: "The Corporation of Cardiff, guided by the Electric Lighting Committee, have so far advanced their scheme for the illumination of the town by electricity that we are able to-day to give a sketch of the lighting station, which will, we hope, at no far distant date cover about an acre of ground on the Canton Common. The site belongs to the Corporation, and is situated close to the Great Western Railway on the northern side, and at the extreme end of Eldon-road. The idea at present is to erect only one-fourth of the building, and the extension of the station will depend upon the demand for electric lighting in the town. The plans prepared by the borough engineer (Mr. W. Harpur, M.I.C.E.) show that the first portion of the station will be 82ft. square. The space allotted for engines and dynamos will be 80ft. by 30ft., with a boiler-house of the same size. Behind the boiler-house and adjoining the Great Western Railway will be the coal-stores, 14ft. by 60ft. The stack which it is proposed to build at present, and which appears to be the larger of the two shown in the sketch, will be 150ft. high. It will be octagonal in form, and its external size will be 8ft. 6in. at the base. One of the reasons which induced the committee to fix upon the Canton Common site is that the station can be easily supplied with fuel, and negotiations with the Great Western Railway Company for a siding from the main line into the works are now proceeding. If a reasonable arrangement can be made a great saving in haulage will be effected. Mr. W. H. Massey, M.I.E.E., has prepared the details for the engines, dynamos, street mains, and services, and from the plans which have been prepared it appears that it is intended, in the first instance, to lay the mains along Eldon-road, Tudor-road, and Wood-street, into St. Mary-street. On reaching the last-mentioned point, there will be branches right and left for the purpose of public lighting, and the supply of electricity to business premises. The streets which it is proposed to light at present are (in addition to St. Mary-street) Duke-street, Castle-street, Queen-street (as far as the Taff Vale Station), St. John's-street, Working-street, Trinity-street, Bute-street (as far as Custom House-street), and round through Custom House-street to St. Mary-street, thus completing the circuit. The estimated cost of the work at present contemplated is £32,500, and the Local Government Board have appointed the 14th of this month for an enquiry into the application made to them for borrowing that sum of money. Mr. Harpur hopes, if the necessary permission is promptly granted, to have the streets named lighted by electricity in the autumn of this year.

Reading—Improvements on the Board of Trade.—At the Reading Town Council last week, a report was presented from the Electric Lighting Committee. Mr. Parfitt moved, and Alderman Monck seconded, the adoption of the report. Mr. Rayment objected, saying that the various proposals of the Electric Lighting Committee ought to come before the Council in due course. Mr. Parfitt said they were absolutely in the hands of the Board of Trade, but the town clerk, with his usual care, urged, on behalf of the Corporation, the views expressed, and they were also supported by the representatives of the company in asking the Board of Trade to give effect to the agreement. The town clerk would give explanations on one or two points as to the result of the conference. The Town Clerk said they had a long discussion with the Board of Trade, largely upon strictly legal points bearing upon the amendments on behalf of the Council. They had made an amendment that if the time ever came for purchasing the company's undertaking, it should not only be free from mortgages but debentures and other like charges. That was a novelty to the Board of Trade, who were naturally tenacious of their model form. Though they did not accept the amendment in the form in which it had been prepared, the Board of Trade were prepared to give effect to it by altering the wording. Another point was they had added to the purchasing clause power to the local authority to raise money by mortgage or otherwise in the event of their determining to purchase the undertaking. That was a novelty, but the counsel to the Board of Trade admitted that it was an omission, and that there should be a special clause. In the draft agreement they had also introduced words never in a provisional order before, for the purpose of putting them in the position of settling beforehand what the system and mode of supply should be. That was a novelty which the Board of Trade did not seem at all to relish. They said that they always consulted the local authority before determining the nature and mode of supply. Moreover, they were furnished with general rules which the Board adopts in settling the supply, and the rules contained clauses which were very satisfactory from their point of view. It was suggested also that instead of having this provision put in, some words should be inserted in the clause which put expressly that they would issue their order after considering the representations of the local authority. That was not absolutely guaranteed yet, but the whole question was under consideration with other points discussed. They would be much better off than with an agreement binding them to an initial system. As far as he understood, the rules of the Board of Trade were elastic, and they would be varied from time to time as improvements arose. So far as he could judge, he was more than satisfied with the interview. He thought they would get substantially what they wanted. Speaking generally, the Board of Trade would protect the local authorities and not the other side. The town would not receive any rental from the company.

The Government and the Trunk Telephones.—Says the *Yorkshire Post*: "The effects of the purchase of the trunk lines of the telephone system by the Government are beginning to be felt in Leeds, Bradford, Huddersfield, Halifax, and other great centres of industry to an extent that may surprise a good many people who are not frequent users of this channel of communication, and which is rather alarming to business firms who are constantly speaking from one city to another. The National Telephone Company have intimated to their patrons that when their current contracts with that company have run out a new arrangement will come into force as far as the method of paying for the use of trunk lines between one city or town and another is concerned. That new arrangement is that there is to be no more renting of trunk wires, and that subscribers to a telephone exchange in any centre will be charged 3d. for every message they send from one town to another. The result of this alteration will be of great moment to the commercial classes as well as to many private residents who use the trunk wires often. For instance, suppose a great manufacturing house has one establishment in Leeds and another in Bradford. Assume that they subscribe £10 a year to the Leeds telephone exchange, and a like sum to the Bradford exchange, they can, by paying a third £10 as rent for the wire from Leeds to Bradford speak from either place to the other as frequently as they desire without further charges being made. This plan seems to have been a great boon in many cases. It is said that were some firms to continue using the trunk wires as much as they have been doing for many years the threepences they will have to pay may amount to four or five times the £10 per annum rent they have thus far been charged. Of course, it is obvious that the paying of threepence for every message will be better than the old rent system for people who have rented trunk wires and not used them much. But if all the complaints now being made are well founded, and the statistics with which some of them are backed up be accurate, more telephone users will suffer financially than are benefited. In some quarters, where the change will be costly and inconvenient, it is suggested that the Imperial authority must have paid too high a figure for these trunk lines, and that it is determined to recoup itself at the expense of the public. Why, it is being asked, cannot the Government agree with the telephone companies to allow renters of trunk wires to continue on the old footing, an equitable division being made of the rents? It is further asserted that in no other industrial country are subscriptions for the use of telephones so high as they are in England. Leeds, Bradford, and other Yorkshire centres of manufacture are merely cited as instances of what is happening all over the country. Perhaps a far more effective illustration of the change is afforded by Manchester and Liverpool, where the receipts for telephoning at 3d. a message will amount to a fabulous sum in a year. It is not improbable that some general representation will be made on the subject to the Government and the telephone companies."

Liverpool Overhead Railway.—The Liverpool electric railway was opened for traffic on Monday. A 10 minutes' service from 7 a.m. to 7 p.m. will be first established, but it is anticipated that in a short while a five minutes' service will be required. General Hutchinson, Major Yorke, and Major Cardew, on behalf of the Board of Trade, finished the official inspection early last week, this necessary formality having been commenced on Sunday, 26th ult. Sunday was chosen owing to the dock traffic on week days interfering with the inspection. After a most rigorous and critical examination the officials at once notified that the Government certificate would be issued. The signalling arrangements were minutely tested, and the structure was loaded with a 50 per cent. greater weight than the running load arranged for. Two weighted trains of three carriages each were run along the rails side by side at full speed, this giving six carriages passing over the same part of the line simultaneously; and as the ordinary trains will only consist of two carriages each, it will be seen that the test was very complete and severe. The arrangements for picking up and laying down passengers are likewise completed, the turnstile method being adopted as the most economical. Passengers on passing through the stiles will pay according to the class of carriage in which they wished to travel, and, as there are two classes, it has been arranged that the second-class passengers will merely pay 2d and pass through without receiving tickets, whereas the first-class passengers will pay 3d. and receive a voucher, which they will be required to give up on demand. Books of tickets have also been issued at the same price as the single tickets—namely, 6s. per book of 24 first-class tickets, and 4s. per book of 24 second-class tickets—and, of course, these tickets will be accepted at the pay-gates as if they were money. It is expected that the book arrangement will be of great use to merchants and others who prefer to adopt this method of giving their employés railway money. It is not intended to issue season tickets, but in the event of a demand for this convenience the best way of meeting it may probably be found in a reduction of the price for large quantities of tickets, rather than in the ordinary railway manner, since the turnstile method would be seriously interfered with if some acknowledgment were not given by each passenger going through. The turnstiles will be closed automatically the moment the trains arrive at the stations, so that no more passengers can pass through till the train itself, by moving off, automatically relieves the block. In the same way the exit gates will not be opened till immediately after the departure of the trains, so that there will be no possibility of any crushing or inconvenience. About half a minute is allowed for the maximum time of stoppage at each station, and, therefore, it is not anticipated that the ingenious method above described will lead to any perceptible delay. Great credit is given in Liverpool to the Electric Construction Company for pluckily undertaking to run the trains for the first two years. The number of passengers carried on the Liverpool electric railway on Monday was 17,541, of which 4,580 were first-class; the receipts were £164. 3s. This was with a 10 minutes' service. The company expect to be able to commence their five minutes' service in about three weeks; and also to run from 5 a.m. to 9 p.m., instead of from 7 a.m. to 7 p.m., as at present.

Doulton's Vitrified Stoneware.—Messrs. Doulton and Co., of Lambeth, have brought out a patent system of hard vitrified stoneware casing for underground electric mains. It possesses great strength and affords a very perfect mechanical construction to insulated cables; it is impervious to water and gas, and the material is imperishable, being capable of withstanding the strongest acids. It is also unaffected by changes of temperature. The casing is made in 3ft. lengths, with two or more ducts, the interior of which possesses a hard, smooth glaze, giving exceptional facilities for drawing cables in and out. The section may be modified as desired, but is made square in standard sizes. The casing may be laid in groups to form a conduit of any desired capacity. Several methods of jointing have been devised. A simple and efficient joint consists in bringing the ends together, and lapping round with prepared canvas enclosed with a stoneware trough. The lower interior surface of this trough receives a layer of Portland cement, which is kept out of the conduits by the canvas band. The trough is then filled up with cement, a reliable joint being thus easily and conveniently made. Where space is a consideration, a light cast-iron collar or trough may be substituted for the stoneware, the same method as last described being adopted. Or the trough may be simply filled with bituminous or other cement, the canvas band being used as above described. A specially-prepared compound, which forms a very suitable and rapidly-setting cement, is recommended for this purpose. These methods of simply connecting the lengths of casing to one another will satisfactorily meet all ordinary requirements. In cases, however, where it is considered advantageous to maintain the complete separation of the ducts where the lengths are connected, the method adopted is as follows: The lengths of casings are laid in the collars with a small space between them. Mandrels with indiarubber heads are then introduced into the ducts, and when opposite the joint between the lengths are expanded by a simple screw arrangement. Molten cement is then poured in and this fills up the space between the casings except where occupied by the mandrels. In two to three minutes the cement will be set, and the mandrels are unscrewed and withdrawn. In this way each duct may be kept entirely separate and continuous with a uniform section throughout the total length of the conduit. Small changes of direction at the joints can be made without interfering with the simplicity or security of the above-named modes of connection. In systems of distribution in which any considerable change of direction is effected by the introduction of a draw-box into the line, Messrs. Doulton are prepared, if required, to provide specially-made watertight stoneware boxes with iron surface-frames and covers to suit any requirements, where the opening does not exceed 2ft. 6in. in its greatest dimension. Where cable T connections have to be made in a main after a line of conduit has been laid on this system, there is no difficulty in removing a length without injury to the cables previously drawn in, and substituting a service-box of stoneware or of ordinary brick. The makers claim that for use underground vitrified stoneware possesses advantages over other materials in its strength, its impermeability, and its quality of withstanding corrosive action, and consequently its absolute durability. The jointing of stoneware tubes by ordinary methods is always attended with some risk, and hitherto, in connection with electrical work, no attempt seems to have been made to overcome the difficulty. Careful attention to this point has been given, and the methods above described are considered eminently practicable and reliable.

Edinburgh.—The monthly meeting of the Edinburgh Merchants' Association was held last week, Mr. D. Grant, the president, in the chair. Mr. J. M Turnbull concluded the reading of a paper on the comparative cost of electric lighting and lighting by gas—the first part of his address having been given at a previous meeting. Dealing in some detail with the arc light as a means of street-lighting, Mr. Turnbull said it was presumably for the purpose of getting more light that the proposal was made for the lighting of city thoroughfares by electricity. Still, it must be remembered that electric lighting of the streets would entail an extra expenditure of about twelve times what the lighting of such a city as Edinburgh by gas at present cost, leaving out of account altogether the capital expense of laying down the plant. If they spent about seven times the amount they at present spent in Edinburgh for gas, or one-half of what the arc light would cost, they would get a light quite satisfactory for all purposes. If, again, for the burners now in use in Edinburgh—which burned 2ft. of gas per hour—were substituted larger burners, burning 4ft. per hour, they would obtain more than double the light they had at present; and if other four lamps were put up between three, as at present—making, in all, seven—with burners using 4ft. per hour, that these seven lamps would give 14 times the light that are at present given by three, and that the cost per year for the seven lamps would be £8. 4s. 5d.—and that this ought to be sufficient for street-lighting—as against one arc lamp costing from £20 to £27 per year. His point was that they would do well to consider before they took such a jump in cost as would be involved in a change from gas to electric light for street purposes at the present rate of gas in Edinburgh. The conclusion he had come to was that electric lighting was an exotic that required careful nursing before it was practicable. With a development of the system of burning gas in regenerative burners, gas need not be afraid of any rival as an illuminant. Councillor John Jamieson said it would be matter for immediate discussion in the Corporation whether electric lighting in Edinburgh should be handed over to a company or kept in the hands of the Town Council. It was anticipated by a great many that, even although there should be a loss for a few years to the Corporation from the working of the electric light, with the improvements which might be expected on that light in due course there would be a gain in the future. He believed on that score there might be some reluctance in giving over the lighting to a company. There might be a great demand for electric light even at such prices as it would be necessary to charge in the first instance, and as the difficulties of taking over a concern once handed to a private company were great, there might be hesitation in allowing it out of the hands of the Corporation. He was afraid Mr. Turnbull had not made full allowance for the improvements which were bound to come in electric lighting. The Secretary expressed his belief in the great possibilities of the electric light; and Mr. D M'Laren said he had no doubt in due time there would not be a tithe of difference between the cost of gas and electricity. The Chairman, in moving a vote of thanks to Mr. Turnbull, said without doubt Edinburgh must move forward in the matter of electric lighting. He had lately visited several cities lighted by electricity, and he had been struck by the excellence of their lighting After some further conversation Mr. Turnbull replied to the discussion, and gave notice that at next meeting he would move that the Town Council should hand over the working of electric light in Edinburgh to a private company.

Manchester Gas Engineers.—At the twenty-third annual meeting of the Manchester District Institution of Gas Engineers on Saturday, the new president (Mr. Chester) delivered his inaugural address. After referring to the useful work done by the institution during the 23 years it has been in existence, he proceeded to speak of the position and prospects of the gas industry, particularly in its relationship to the electric light. He said that during the period which had elapsed since the Paris Exhibition of 1881, when the practicability of illuminating by electricity was demonstrated on a large scale and the investing public were first dazzled by its display, every year had brought us some new and startling discovery by which gas as a domestic illuminant was to be snuffed out. In the 10 or 11 years which had elapsed hundreds of electric lighting companies had been registered with millions of capital. In Great Britain alone electric lighting companies had been registered with a total nominal capital of £9,700,000, of which £3,820,000 had been called up, and this sum was exclusive of the amount expended by municipalities and local authorities, of which at present we had no return. How far this capital had been wisely expended might be judged by the limited number of companies able to show any commercial success. Where success had been obtained it would be found that the company was in possession of some compact and rich district of supply in which cost was only a secondary consideration to the consumer. If we took 6d. per Board of Trade unit of 1,000 watts as the price at which electricity could be profitably supplied and compared this figure with that of 18-c.p. gas at 2s.6d. per 1,000 cubic feet, we got a comparative cost, light for light, of rather more than two to one in favour of gas. So long as these proportions were maintained it would be impossible to supersede gas or diminish its popularity as a domestic illuminant. While every new electrical invention had been heralded by the Press with a great flourish of trumpets, and new companies for its supply had sprung up with marvellous rapidity, the consumption of gas had steadily increased, and the prosperity of the undertakings supplying it had been maintained. The total capital invested in authorised gas undertakings in 1882 was £50,261,118, and in 1892 it was £63,620,461, showing an increase of 26·6 per cent. in the 10 years, while in the same period the consumption of gas had increased to the extent of 50 per cent. This steady rate of increase was the more satisfactory when it was borne in mind that it had been won in competition both with the electric light and with the light obtained from the cheap mineral oils which had been placed on the markets in such abundance during the past 10 years. In commencing the second decade of the electric lighting era gas engineers had less cause for anxiety than existed 10 years ago. They were now in a position to more correctly estimate the cost of production of the electric light, to gauge its possibilities, and to pretty accurately determine its usefulness. The mind of the public as well as that of the timid shareholder had now become more settled, and it was generally recognised that their two systems had their respective spheres of usefulness, and could be run in double harness almost without competition, and with mutual benefit to the consumers and to the public at large. It might, he thought, be safely anticipated that in the next decade the prosperity of gas undertakings would not be diminished. The stimulating influence of a friendly competition would more rapidly develop the latent resources of the gas manufacturer, production would be cheapened, and, as a natural consequence, consumption would increase.

Economies of Electric Lighting.—A meeting of the Architectural Section of the Philosophical Society of Glasgow was held in the Upper Hall, Glasgow, last week, when Mr. T. Crichton Fulton, electrical engineer, read a paper on "The Economies of Electric Lighting and Power Transmission." Mr. Campbell Douglas occupied the chair. Mr. Fulton, at the outset, drew attention to three aspects of the question which he wished to present, though he would make no attempt rigidly so to divide his treatment of the subject: (1) The economy which results from the use of electricity; (2) economy in the choice and erection of the necessary plant; and (3) economy in the use of the plant itself. Proceeding to treat of the manner in which electricity is generated in large quantities in modern days, he briefly showed how this was effected, and pointed out that the two essentials were a dynamo and some mechanical means of rotating its armature. The means adopted varied with varying conditions. If water power was handy, it was by far the most economical, especially if there were facility for storage and an ample supply. Where coal was very cheap steam engines and boilers might be found more suitable, though their efficiency of conversion was certainly very low indeed. Where neither of these prime movers was convenient, gas-engines, which had been enormously improved of late years as regards efficiency, steadiness, and freedom from noise, and which were both cleanly and handy to work, would be found of great service. There were many mills, factories, etc., which had a considerably greater power—either engine power or boiler power, or both—than was needed to drive their machinery, and certainly it would be a direct economy to use this surplus power for lighting the premises. In speaking of the distribution of the current, the lecturer condemned as a very "penny-wise-and-pound-foolish" policy the use of two small conductors, or of conductors which were not well insulated. Too small conductors caused too great frictional resistance; this again caused heating of the conductor, which was not merely a source of waste, but a positive menace to life and property. He then described shortly the construction and action of incandescent lamps, and pointed out how much superior they were to our present modes of lighting as regards health, cleanliness, safety, and steadiness. The arc light was next touched upon, and was shown to be both suitable and economical for large buildings and open spaces, such as harbours, stations, and public streets. This light was not merely the safest, but by far the most economical to use for such places as chemical works, match factories, timber yards, paper mills (where the processes have to be carried on night and day), hospitals, and dwelling-houses. In speaking of the transmission of energy by means of electricity, Mr. Fulton instanced the cases of a mine in New Zealand, where the generating plant was placed near the coast, and the current transmitted five miles to the mines, which were situated some 2,000ft. above the sea-level; and of the recent experiments in Germany, when 72 per cent. of the water power derived from the falls of Lauffen was transmitted over 100 miles to the Frankfort Exhibition, there to be retransformed into mechanical energy by means of electromotors. Small electromotors were quite as efficient as large ones, which steam-engines were not, and the time might not be far distant when, in some industries at least, the present plan of centralising the whole operations in one huge factory might be changed for one in which workmen carried out many of the processes by the aid of electricity at their own fireside. The lecturer next gave his audience some idea as to the cost of erecting and working installations, though this could not be done with any accuracy owing to the great variety of conditions. It was necessary, however, to have the work properly planned and arranged, and thoroughly superintended and tested, in order to avoid as much as possible the risk of failure, annoyance, and frequent outlays for alterations and repairs very soon after the work had been completed. This could only be done adequately by having skilled advice from an independent source. The lecture was illustrated throughout by numerous experiments and limelight views. At the close a hearty vote of thanks was accorded to Mr. Fulton for his paper.

Leeds Tramways.—The *Bradford Observer* has the following article on the Leeds tramways, in which it deals with probable changes in administration: "Owing to the differences between the Leeds Tramways Company and the Leeds Corporation the inhabitants of the city are suffering great inconvenience. It was supposed that these differences would have been settled long ago, but the deadlock appears now to be worse than ever, and the settlement is said to be waiting a decision of the law courts as to the amount which the Corporation will have to pay the company. In the meantime the tramway dividend has fallen to 3 per cent.; the steam trams have long ceased to run on the Headingley route, one of the best paying sections; the fares are raised; the service is slow and indifferent; the cars are not kept in as good condition as they once were, especially on the New Wortley section; development, which is greatly needed, is at a standstill; and finally, thousands of pounds are annually being lost through the absence of facilities for reaching distant parts of the city. The electric tramway to the entrance of Roundhay Park, worked on an admirable system by Mr. Graff Baker and his friends, does not pay because of want of communication with the centre of the city, and altogether the Leeds tramways are in a sad state of disorganisation. The electric cars are beautifully fitted up, lighted by electricity, are kept uncommonly clean, are smart in appearance, and are worked by civil and obliging men, in uniform, who present a very marked contrast to the poorly-clad drivers and conductors in charge of the tramway company's cars. Mr. Baker is prepared to carry out this system throughout the city. Instead of having posts in the streets to hold the conducting wires he would fasten wires to the buildings on each side, but the streets would still have to be crossed by wires at a height of 21ft. This is held to be objectionable, because the Leeds fire-escapes could not pass under the wires at that height. In America the escapes are carried horizontally, and this difficulty is obviated. Portions of the Headingley section have been substantially laid with steel rails, suitable for the passage of steam trams, but other portions are defective, and consequently the steam trams are stopped, and the service is most inefficiently worked with horses. Longer time is taken in the journeys, not half the number of people can be carried, and late at night, when a dozen steam trams, carrying more than 60 people each, could be readily filled, one or two horse cars have to suffice. The result to the public who wish to pay their money to travel, but cannot, may readily be imagined. A similar remark will apply to other sections of the tramways. The most absurd thing, however, is that the electric cars do not approach within nearly a mile of the centre of the city, and only touch the fringe of Roundhay Park. The inconvenience to people who have business in Leeds is quite as great as to the residents. Omnibuses are multiplied *ad infinitum*, but still the demand is not met, nor is the accommodation such as is desirable. The Corporation propose, when they do get possession of the tramways, to lay some 24 miles of new lines in various quarters of the city, and to remodel the existing lines, but no one can tell when that desirable consummation is likely to come about. Mr. Graff Baker's lease of the Roundhay route expires in November next, and he proposes to tender for working the whole city with electricity on the admirable system he has inaugurated on the Roundhay-road. There is another grave difficulty to be surmounted. Briggate and Boar-lane are congested with tramcars and omnibuses which impede the ordinary traffic, and are a constant source of obstruction and danger. It is suggested that City-square should be made the central starting-point for all the trams and 'buses. The square is near all the railway stations, and would be very convenient. The south side of Leeds is served by only one line of tramway, extending to Thwaite Gate, while to the right of that line the population has immensely increased in Holbeck and Hunslet, and three or four lines are needed, which are now inefficiently served by 'buses. The laying out of Cross Flatts Park, on the heights of Beeston Hill, has stimulated building operations. Hundreds of cottage houses have been erected, and round the park a better class of property is rising, the residents in which are naturally anxious for a tram service in place of the jolting and often foul-smelling 'buses. The Corporation have taken Meadow-lane in hand, are widening it, and removing some of the old and squalid tenements which rendered this portion of the city both unsightly and unwholesome. One reason why tramways have not been introduced into this thickly-populated quarter is that most of the leading streets are too narrow for tramcars, but if the corner of Mill-hill were rounded and better access given to Neville-street, there would be no difficulty in laying a line in that direction to Meadow-lane, and onward to Holbeck and Hunslet Moors, as well as to Beeston Hill. This question of the development of the Leeds tramway system is forcing itself on attention, and when the Corporation do acquire the company's lines there will be plenty of work in store for them."

PROVISIONAL PATENTS, 1893.

FEBRUARY 27.

4241. **Electrical foghorn, thief detector, and alarm.** Alfred Bezant, 22, Oxford-road, Waterloo, Liverpool.

FEBRUARY 28.

4330. **Improvements in coupling joints for couplings of electric mains.** Henry White Bowden, 46, Werter-road, Putney, London.

4368. **Improvements in electric arc lamps.** Barton Brewer Ward, 52, Chancery-lane, London. (Complete specification.)

4356. **Improvements in or relating to welding metals electrically.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

4360. **Improvements in the construction of plates for accumulators or secondary batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (La Société Electric Phœbus, France.)

4363. **Improvements in or connected with electric railways.** William Phillips Thompson, 6, Lord-street, Liverpool. (James Hervey Bates, United States.) (Complete specification.)

4369. **A combined flame and incandescent lamp.** Frederick Siemens, 28, Southampton-buildings, Chancery-lane, London.

4390. **Improvements in electric arc lamps.** Edouard Cannevel, 28, Southampton-buildings, Chancery-lane, London.

4416. **Improvements in dynamo electric machines.** Dani Fé y Ferandez, 1, Queen Victoria-street, London.

MARCH 1.

4425. **Improvements applicable to gas and electric lamps for automatically turning the light up and down.** Thomas Gill, 3, Commercial-street, Halifax.

4489. **Improvements in and relating to electric fire alarms.** Emil Carl Christian Krogh, 77, Chancery-lane, London. (Complete specification.)

MARCH 2.

4546. **Improvements in and relating to stepped pillars or standards for carrying electric lights, wire, and the like.** John Bell Millar, 96, Buchanan-street, Glasgow.

4577. **Improvements in electrical distribution of energy and in apparatus therefor.** Rankin Kennedy, 1, Clifton-villas, Camden-square, London.

MARCH 3.

4691. **Improvements in the manufacture and production of elements for secondary batteries.** The Lithanode and General Electric Company, Limited, and Job Thomas Niblett, 47, Lincoln's-inn-fields, London.

MARCH 4.

4726. **Improvements in the electrolytic production of chlorate of potash and chlorate of soda.** John Ashton Heap, 15, Corinne-road, Tufnell Park, London.

4731. **Improvements in and relating to the measuring of electricity, and in meters therefor.** Rankin Kennedy, 1, Clifton-villas, Camden-square, London.

4734. **Electric fog-signalling, and the better prevention of accidents by collision on railways.** Stephen Gerald Kirk, Victoria-road, Netherfield, Nottingham.

4746. **Improvements in incandescent electric lamps.** Oliver Imray, 28 Southampton-buildings, Chancery-lane, London. (Turner D. Bottom, United States.) (Complete specification.)

4759. **Improvements in electrical resistances.** William Maxse Meredith, 55, Chancery-lane, London.

4772. **Insulating and preserving metal arms used for supporting electric telegraph insulators and for kindred purposes.** Thomas George Marsh, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

2652. **Voltaic arc lamps.** Klostermann.

3240. **Door handles, electrical insulators, etc.** Lang.

5655. **Electric safety lamp.** Rees.

6888. **Electric conductors.** Spence.

6989. **Casings for electrical conductors, etc.** McMullen.

23906. **Incandescent electric lamps.** Prentiss.

1893.

140. **Storage batteries.** Harris.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3 3/16
— Pref.	—	2 3/16
City of London	—	12 3/4
Electric Construction	10	4
Gatti's	—	5 1/4
House-to-House	5	5 3/8
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5 7/8
	3	4 1/8
London Electric Supply	5	3/4
Metropolitan Electric Supply	—	5 1/2
National Telephone	5	5 1/4
St. James'	—	8
Swan United	3 1/2	3 1/8
Westminster Electric	—	5 3/4

NOTES.

Bell Patents.—The famous patent by Prof. Alexander Graham Bell for telephones in America expired on March 7.

Lecture at Blackpool.—Mr. J. Hesketh, the Blackpool borough electrical engineer, will shortly give a lecture on the subject of electricity in connection with the technical school.

Electric Light in the Holy Land.—The electric light has been introduced into a new flour mill near to the supposed site of Calvary, and close to the Damascus gate at Jerusalem.

Switzerland.—*L'Industrie Electrique* gives (March 10) a list of 80 central electric stations in Switzerland, with name of owners, horse-power, makers, alternate or continuous system, system of distribution.

Appointment Open.—The position of headmaster in the public school of science and technical school at Cheltenham is vacant, with a salary of about £250. Applications [illegible] be made to the hon. secretary, 6, Wellington-square, Cheltenham.

Hanover Central Station.—A very full description, with plans, diagrams, and illustrations of machinery, is given of the Hanover central station in the *Elektrotechnische Zeitschrift* for March 3rd. Schuckert steam dynamos are used.

The Electropathic Belt Case.—The *Lancet* says, referring to this notorious case, "We consider that there never was a case in which severity was more merited by the circumstances of the offence or better calculated to prevent its repetition than the present."

Electricity in Mining.—The thirteenth lecture on "Practical Coal-Mining," under the auspices of the Notts. County Council Technical Instruction Committee, was given last Monday in the Annesley National Schools, by Mr. H. Stoker, the subject being "Electricity, as Applied to Coal-Mining."

Stenotelegraphy.—A long article on telegraphing in shorthand on the Jaite system appears in the *Elektrotechnische Zeitschrift* for the 3rd inst. The scheme includes points arranged to indicate affixes and suffixes—such as qua-, -tional, -ment, and so forth—as well as single international signs for days of the week, words like "bank," and for numbers."

Solid Air.—Prof. Dewar has succeeded in producing not only liquefied, but solid air. It is doubtful whether this is a jelly of nitrogen and gaseous oxygen, or a true ice of liquid air. This doubt exists, as pure oxygen has hitherto resisted attempts to solidify it, while nitrogen can be frozen with comparative ease.

British Association.—The next British Association meeting will be held at Nottingham, commencing on Wednesday, September 13. The president-elect is Dr. J. S. Burdon-Saunderson, professor of physiology at Oxford. Memoirs intended for this meeting should be sent to the secretary, at Burlington House, W.

Institution.—At the meeting of the Institution next Thursday, the 23rd inst., a paper will be read "On a New Form of Portable Photometer," by Sir David Salomons, member; "On Earth Currents in India," by E. O. Walker. C.I.E., member; and "Notes on the Influence of Electricity on Tanning Operations," by C. K. Falkenstein, associate.

Coupling Alternators.—M. Paul Boucherot has a careful article, mathematically treated and illustrated by diagrams showing connections, on the coupling of alternators in *L'Industrie Electrique* for the 10th inst. He shows six different methods of coupling by induction coil and condensers. The cost of the apparatus proposed is given as a few pounds per kilowatt.

Electric Cabs.—In Berlin last Saturday the so-called electric cab, which is really propelled by means of a petroleum motor ignited by an electric spark, met with a mishap. While near the Hotel Kaiserhof the cistern, which hangs between the two back wheels, burst with a loud report, and the fluid ran out on to the road. The occurrence caused great merriment amongst the cabmen on the stand in front of the Kaiserhof.

Retirement.—Mr. Edward Summerfield, who has been chief engineer of telegraphs for the Northern District since the acquirement of the telegraph system by the Post Office Department, will retire, in accordance with the provisions of the special Act of Parliament of 1876 making it compulsory to retire at 60 years of age, on March 28. Mr. Summerfield's connection with telegraphy dates from 1850, and he is thus one of the oldest men in the service.

Electrical Journalism.—In its issue for March 4 the *Electrical World*, the well-known American electrical journal, begins its twentieth year. Started in 1874 as the *Operator*, a small four-page paper devoted exclusively to telegraphy, it has grown with the growth of electrical engineering, and now appears as the largest electrical journal with a weekly circulation of 12,250 copies—a standing testimony to the immense and growing importance of the electrical industry.

Tesla Lecture.—Mr. Tesla's lecture at St. Louis was attended by 4,000 people, the great Exhibition Theatre being crowded to suffocation. Mr. Tesla had naturally to confine himself mostly to spectacular effects, which were of a very beautiful description. Prof. Forbes was on the platform. Mr. Tesla said he believed we were about to see great powers transmitted long distances and over a single wire. An enthusiastic reception was held after the lecture.

Lithanode.—An improved form of this material has recently been produced by Mr. Desmond FitzGerald, the original inventor, and is now being experimentally tested. The mixture used possesses the advantages of increased plasticity, of not "setting" with inconvenient rapidity, and of producing, without any admixture of crystals, a finely-porous substance which can be "formed" or converted from protoxide into peroxide in a tithe of the period formerly necessary.

Electric Machine Tools.—An interesting article is given in *Elecktrotechnische Zeitschrift* of the 10th inst., by Herr Richter, on the great progress now made in the electric working of machine tools. Reproduction of photographs of electric cranes, planing machines, lathes, centrifugal separators, drills, elevators, and so forth, by Siemens and Halske, are given. An intermittent eccentric press and a lathe for turning armatures are also illustrated. A number of working drawings of electric tools will prove useful to electrical engineers.

Carbon Brushes.—M. Eric Gérard says, with reference to his carbon brushes, that the carbon blocks, offering a specific resistance of contact with the commutator much higher than that of the metal brushes, cannot be substituted for these latter for low-tension dynamos without serious loss at the commutator. But it is naturally no longer the same if the commutator is specially designed to allow carbon blocks of considerable surface, admitting a low density of current. The addition of plates of copper to the plates of carbon provides another satisfactory solution, the carbon being placed in front, in relation to the direction of rotation of the armature.

Rating of Machinery.—The Rating of Machinery Bill has obtained the first place on Wednesday, April 5. But as that day will probably be included in the Easter holidays, however much they may be curtailed, the promoters of the measure, says the *Daily News*, may have again to try their luck at the ballot-box. Whenever the Bill reaches Committee, Mr. Powell Williams will move an amendment providing that machinery or plant used for producing or transmitting first motive power shall not be assessed for the purposes of rating at less than £50 for each nominal horse-power.

Long-Distance Telegraphy.—A noticeable feat of land telegraphy is recorded recently in India. Calcutta was linked up with Madras by way of Nagpore and Bombay, and duplex messages were transmitted direct on what was really one continuous wire, without having to be repeated at any of the intervening stations. The distance was 2,100 miles, and the wire employed was of copper. This feat was rendered possible by the employment of some apparatus introduced by Mr. Melhuish, of the Telegraph Department. A new and heavier copper wire is now being laid from Calcutta, through Dhond and Manmad, to Madras. When it is ready the service along it will be unequalled among land telegraphs in the world. The necessity for this route arises from the fact that the line along the East Coast is subject to constant interruptions, and is most difficult to maintain in working order, especially during the monsoon seasons.

Blind Operators for Telephones.—There exists a great need for the congenial employment of blind people, "and," says the *Lancet*, "there are indications that the demand may be satisfied. As an illustration we may mention the recent introduction by Mr. F. W. Smith, of Brighton, of a typewriter intended for the use of blind persons which prints embossed characters and is adapted to any type. This invention, we repeat, is noteworthy, not only for its own sake, but as indicating the growth of a purpose which promises to bring more and more within reach of the hitherto incapable blind a considerable part at least of the privilege of work enjoyed by their seeing neighbours. We might suggest the telephone and even the telegraph systems as other possible outlets for their energies." This suggestion of our medical contemporary may be worth the attention of telephone managers. For those who wish to pursue the enquiry to a practical issue we should recommend them to communicate with Mr. Guy Campbell, of the Royal Normal College for the Blind, Upper Norwood.

African Overland Telegraph.—Telegraphic communication with Cairo or even with Uganda will be difficult to maintain, says the *Cape Times*, if the ways of the Makalala and Matabele and even of the European carriers in the Zambesian territory may be accepted as indicative of the probabilities farther northward. An official report is just to hand of serious damage to the line of telegraph, not from the elephants, of which the original projector of the trans-continental line confessed some apprehension, but from covetous natives and selfish transport riders. The thick line wire of the stays is very handy for the repair of the carriers' trek-touws, while the finer wire is the very thing for the manufacture of necklaces and bangles for Makalala belles. It was thought once that a convenient superstition would protect the wire from native depredation, but human vanity is more powerful than superstition. The immense lengths of unguarded wire give a serious aspect to this newly-developed danger. Sharp and summary punishments may be reckoned upon when the thief is caught, but the chances of escape defy measurement in odds where the line runs for hundreds of miles through a country in which a policeman is a less familiar object than a lion.

Central-Station Design.—A series of articles on "The Design of a Central Station for Incandescent Electric Lights" is commenced on March 4 in the *Electrical World*. The requirements in considering the establishment of a central station are—(1) present wants; (2) future probabilities; (3) plans for station; (4) method of working the station. Prof. Roberts gives a skeleton of the consulting electrical engineer's report to a committee, and discusses how this business should be gone about. A good man should not be cheap, and should, like an architect, stick out for his 5 per cent. His time should be well paid; a competent man will, by taking time, design a station costing 10 per cent. less to work than if the design were produced cheaply and hurriedly. Proper preliminary investigations, proper plans, correct specifications, and contracts, with fines for non-arrival of machinery to time, proper inspection, proper direction and control as to working—these are needed, and when obtained the desired dividends should not be long in appearing. A series of designs for a town of 10,000 inhabitants is to be given, continued exactly as if it were the report of a consulting electric station specialist made to the investigating committee.

Tenders Wanted for Liege.—The Administration Communale of Liège, Belgium, is asking for tenders for the erection and working of a central electric lighting station, details of which are contained in the specification obtainable of M. Boulanger, chef de la Division des Travaux de la Ville. The duration of the concession is for 25 years, at the end of which the whole of the buildings, plant, mains, public lamps, etc., become the property of the town, without the latter paying for anything but the site, which the contractor must purchase at the outset. By, however, giving a year's notice in advance, the town may acquire the undertaking at its then value either in 1903, 1908, or in 1913. No particulars are given as to the possible number of lamps which may be required for private illumination, but the town guarantees annually a consumption, including the use of current for lighting the municipal buildings, of 34 kilowatts during 1,460 hours of full lighting, and of 17 kilowatts during 1,740 hours. Contractors have to state their proposed maximum charges for current for different ranges of consumption, and after deducting out of net profits 6 per cent. interest on the capital invested, one-third of the balance will be paid over to the town and the remaining two-thirds will belong to the contractor. The conditions throughout the specification do not seem favourable to contractors, but there might be something in the concession.

A Magnetic Screen at Oxford.—During the last vacation, St. John's College, Oxford, has been lit with the electric light, and a transformer of the dynamomotor type, weighing over seven tons, has been placed within about 60ft. of the electrical testing-room of the Millard Laboratory, which is furnished with several reflecting galvanometers. I greatly feared (writes Mr. F. J. Smith, of Trinity College, to *Nature*) that the instruments would suffer much from the magnetic field of the large transformer. When it was found that no other space could be given up for the machine, I devised a method of construction which the Oxford Electric Lighting Company very kindly carried out for me when building their dynamo-house. My method is to construct a wall of scrap iron round the three sides of the dynamo nearest to our laboratory. The iron wall is about 8in. thick, and is made by building two brick walls parallel to one another, and filling the interspace with scrap iron; a delicate magneto-meter used for testing the field at unprotected and protected points equi-distant from the magnets, when the machine is in action and not so, shows that the iron wall is an effective barrier to the magnetic influence. I venture to make known this method of shielding off a magnetic field, because in these days of electrical invasion it may be of use in protecting physical instruments from being seriously disturbed, and rendered useless for any but the roughest determinations.

Luminous Air.—Dr. Philip Lenard, of Bonn, assistant to Prof. Hertz, has recently exhibited a novel light produced by electric oscillations, and a paper has been read on the subject before the Royal Prussian Academy of Sciences, at Berlin. Hertz has shown that the rays proceeding from the cathode of a Geissler tube, which are capable of exciting phosphorescence, will pass through thin metal. If it were practicable to find a sheet of metal foil thick enough to be airtight and opaque, yet thin enough to be permeable by this discharge, it would be possible to allow these rays a passage into the open air by closing an opening in a discharge-tube with such a piece of foil. This idea has been realised by Dr. Lenard by means of an ingeniously-arranged apparatus and a hammered aluminium plate 0·003 millimetre thick. This plate forms in the apparatus in question a shutter which Dr. Lenard calls the "window," because, while quite impermeable to air and light, it allows the rays from a cathode at a distance of 12 centimetres to penetrate it freely. These rays render the air faintly luminous. A halo of bluish light surrounds the "window," and is moderately bright only on its surface. At the same time a strong odour of ozone is recognisable. Substances capable of phosphorescence, if held near the "window," shine with their peculiar light on the side nearest to it. All the phenomena of phosphorescence cease if a magnet is so applied to the discharge-tube as to repel the cathode rays from the inner side of the "window." The atmosphere is a dull medium for the cathode rays to penetrate; coal-gas is more permeable, and so is hydrogen; while oxygen and carbonic acid are less permeable than air.

Portable Transformers.—Our readers may be interested to know that our article of last week on Sir David Salomons's "combination" transformer was productive of an enquiry from gentlemen interested in the exploitation of ozone, and that there is every probability of convenient "combinations" for the liberation of this valuable constituent of our atmosphere in any situation where an alternating current is available. It may be imagined that the benefit to health of those employed in crowded city offices and haunts of business may be considerable; that we shall be less cursed with influenza, and cholera will be put to rout; and, *enfin*, we may see a more robust and healthier type of clerk, with lungs expanded by the easily-liberated ozone. We shall, on sultry days, hear the remark: "How close it is! Turn on the transformer, and let us have a little fresh ozone." There is nothing too improbable about this—as may be felt on remembering the incredulity with which electric motors, or more lately, electric cooking, have been regarded; and pure air should be one of man's most cherished possessions. Sir David Salomons also points out that he obtains from the small transformer a very powerful flame arc of a similar character to that obtained by the Siemens and Swinburne high-tension transformers, as shown at the Crystal Palace Exhibition; this flame being due to the consumption of the nitrogen by the oxygen of the air, as pointed out by Prof. Crookes. It remains to be seen if there is any industrial application of this effect. In any case, the portable high-tension transformers will have their value; and the absence of danger, by reason of the minuteness of the current, will be a point in its favour.

Mining.—We have received a copy of *The Science and Art of Mining*, a fortnightly periodical, price 3d., published at Wigan and at Bouverie House, Salisbury-square, E.C. It contains much practical information on mining, and a great deal of instructive correspondence. "A Colliery Electrician" writes to advise electric motors for underground hauling. Comparing the three usual methods, he finds that electricity is by far the cheapest for long distances, compressed air being more expensive than wire rope. As to working cost, taking the same three methods, he says: "We find that wire rope is again cheapest in working cost for short distances, electricity coming next, and then compressed air; while for long distances electricity again shows best of the three. As to reliability, I have had considerable experience in colliery engineering, and I have not seen more than two electric motors fail in the last seven years, and those machines which did fail were of inferior construction; as regards safety, motors for haulage are usually placed in main roads where there is plenty of air, while if any apprehension is felt, there are several devices available which have been tested in actual use, and which will render an electric motor safe in any possible contingency." The paper has an educational scheme under the direction of C. M. Percy, M.E., F.G.S., of the Wigan School of Mines, 27, Wallgate, Wigan, the charge being 1s. a month. The articles are brightly written, and the journal is full of information for those who have to do with mining.

Model Electric Yacht.—For over two years M. Tissot, of the Messageries Maritimes, at Kobe, Japan, has occupied his leisure moments in the construction of a miniature vessel propelled by electricity. Its trial trip took place at the naval yard, Ohuo, on January 21. The result is reported to have been extremely gratifying, the vessel obeying the helm and going ahead or astern with great precision. The little boat is exquisitely finished; pretty electric lights serve for port and starboard light; the deck-houses, the means for letting go the anchor, masts, rigging, and steering apparatus, all are beautifully completed. There are staterooms, saloon, and captain's cabin, while boats are on the davits, and the porthole windows open and shut. The "Hirio" is a three-masted brigantine, built of wood, with copper sheathing below the water-line, and is propelled by a three-bladed screw driven by electric motor placed below the main deck. This motor is connected with a tiny pump to clear the hold in case of a leak. The electric power is stored in four accumulators connected together in series, and placed below, between the fore and main masts. A special commutator placed on deck enables one to set the engine full speed ahead or astern, while the speed may be regulated by a resistance also placed on deck. The decks are so fitted that portions over the engine and accumulators may be lifted out. The hull of the "Hirio" is 150 centimetres long, of 28½ centimetres beam, and 15 centimetres depth. Rigging included, the length is 184½ centimetres, and the height 122½ centimetres. She draws 16½ centimetres forward, and 18½ aft. The engine will work about an hour, and it requires an electric power of eight volts and two amperes, which may be obtained either from a primary battery or a dynamo. Altogether the model yacht is an admirable piece of workmanship.

Grounding Wires.—M. Dobrowolski, before the Elektrotechnische Verein, in Berlin, gave an interesting account of the testing of the Frankfort wires. "The grounding of the neutral wire is peremptorily demanded," says M. Dobrowolski, "and is the greatest possible safeguard against danger. This necessity is accentuated in high-potential installations with aerial wires. Without an arrangement of first-class grounds I should have fallen a victim to the Lauffen-Frankfort transmission. Amongst other things, the authorities required actual proof that should a conductor break and fall upon the adjacent railway line, the conductor could be touched and removed with absolute impunity. I placed a sufficient number of fuses on the low as well as the high-pressure circuit. I interposed several electromagnetic minimum and maximum cut-outs on the switchboard, and finally connected the neutral points of both windings of the transformer with a first-rate ground, a copper cable deeply immersed in the River Neckar. The idea, of course, was, should there be a short circuit, the fuses would at once act and cut out the circuit. At the examination of State experts, I requested some of the gentlemen to remain at the station, and the rest accompanied me to a point on the line where arrangements had been made for cutting the line carrying the high-voltage current so as to throw the line on the railway track. As soon as the conductor touched the rails, a great flame seemed to leap from the ground. I immediately went to the spot, lifted the conductor off the rails, and thus convinced the experts of the safety of the line construction. A failure to ground at the neutral point at the Lauffen transformer would have made that attempt my last earthly electrical experiment. In that case, even though the current ceased, the electrostatic capacity would have been sufficient to kill me instantaneously."

Electric Oscillations of High Frequency.—The literature of this fascinating subject cannot be said, as yet, to be very extensive or very well digested, though it is rapidly growing. The probable future importance of the application of what have been termed vibratory currents make it very desirable that all students of electrical subjects should study the theory, and whatever of practice has been obtained, with more than ordinary interest, for in this direction lie the electrician's most ardent hopes. Beginning with Hertz in his experimental researches on electrical oscillations, we have a series of experimenters gradually throwing more and more light on a curiously imaginative branch of electro-physics. Dr. Lodge in England, in his "Modern Views of Electricity" and elsewhere, and Prof. J. J. Thomson (in *Phil. Mag.* and other places), have done much towards bringing this field of research into prominence. No one has, however, created a greater interest in the subject than Mr. Nikola Tesla, whose lecture at the Royal Institution, before the Institution of Electrical Engineers, as revised and published, is a perfect storehouse of little-known and important facts and considerations. This lecture forms one of the issues of the *Journal* of the Institution (Spon, price 5s.) in complete form, and was published in our own columns, running through several weeks. The researches of Crookes on high vacua form an essential part of the investigation, and in his presidential address to the Electrical Engineers, and in communications to the Chemical and other societies, are placed before the present-day student considerations of molecular electrical effects which have led (as in the case of Tesla, who gratefully acknowledged them) to very important results. French investigators — always exceedingly skilful in these delicate researches and manipulation—have been engaged in precising certain details and figures. MM. Sarrasin and De la Rive in *Comptes Rendus* have described their investigations: with large resonators erected on the Geneva Waterworks, they have practically demonstrated the truth of Maxwell's theories. Dr. Lenard, Prof. Hertz's painstaking assistant at Bonn, has devoted much attention to the subject. Prof. Birkeland, of Christiania, has shown how to use a telephone in a resonator circuit, and in *Wiedemann's Annalen* (November, 1892) describes his experiments. Prof. Bjerknes has used the electrometer for measuring the effect of oscillations, and his results were recently discussed by Tesla in the N.Y. *Electrical Engineer*. A series of articles is appearing in the *Electrical World*, by Ervin S. Ferry, on the subject of electrical oscillations of high frequency, giving a careful *résumé* of the later research. The means of testing quantitatively the effects of such oscillatory currents are referred to as four: the elongation of a thin wire by heat, the bolometer, the electrometer, and the thermo element. Cornell University is giving considerable attention to the theory of oscillations, and their physical laboratory possesses original apparatus. The continued practical investigations by Mr. L. Pyke and Sir David Salomons were alluded to in our last issue. Numerous experimenters are attacking the problem of the practical application of vibratory currents, and it would be well if more frequent and complete record were presented to the journals of original work in this direction.

Alternating-Current Troubles.—It is always instructive when a central-station engineer of experience will step down from that pinnacle of impenetrable silence which most of them affect, either from modesty or press of work, and will give practical details and hints of the working of their machinery. Why we have not more of this interchange of experience in England we do not know. Mr. Reginald Wallis-Jones started the ball in a paper some years back on "Diseases of Dynamos," a paper which, if not comprising any very orderly arrangement nor too careful literary style, certainly embodied a large number of facts and details of experience which we know was greatly appreciated. Continuous-current practice has advanced since that day, and electrical engineers generally know exactly beforehand what will happen and what to do under the given circumstances. Alternating-current systems, however, are not yet quite in the same category, and the possibilities of the "wavy" as distinct from the "flow" current, lie dimly upon a vast horizon which every year's discoveries seem to widen. Facts and experience are wanted, and large or small, in laboratory or station practice, data upon alternate-current working are welcome. As an instance of the modest contribution to a subject which has so recently received such skilful treatment, on a larger scale, by Dr. Fleming, we may instance a paper, by Mr. R. H. Sterling, on "Experiences with the Alternating System," given before the National Electric Light Association, and reproduced in our New York namesake for the 8th inst. Mr. Sterling's company was the first to instal a large alternating plant—a policy time has shown to be wise. He gives some results of his practice, which we will endeavour to summarise very briefly. The switchboard is of marble, for safety and appearance, and the 'bus bars run horizontally, with a panel for each feeder and plugs to connect. The fuses should be at the back or out of the way—"as it is unpleasant to have a fuse blow in one's face." To prevent a fuse arcing and melting the contact, he covers the wire with a thin roll of asbestos paper pasted with silicate of soda, so that when the fuse goes the gases blow out the arc. Fuse wire is reliable as regards capacity, but not as regards contacts. A lead fuse, either wire or flat, should never be screwed down under a screw or washer—the soft metal loosens and melts. The one way out of this is a flat copper fuse terminal, slotted to slide under the screw-head—everywhere, in the station and outside — their adoption would save many pounds; "nine-tenths of fuses going are due to loose contacts." This, however, is common to all systems. Now as to alternating dynamos. As the stations increase in size an element of danger occurs in a violent arcing following from one set of contacts to another, throwing two dynamos in parallel, and perhaps destroying the armature. This annoyance is only met in long feeders with many transformers, and is due to inductive discharge similar to the extra current of a field magnet. Its occurrence depends on the period of phase, and is proportional to the length of line and number of transformers. The switches should be placed horizontally, so that any arc rises and blows itself out. As alternating stations increase and large units are adopted, devices are required for regulating pressure on the various feeders. A pressure-raiser is termed a "booster"—boost being, as schoolboys will know, to raise a person by pushing him up a wall. If a transformer is taken whose capacity equals the maximum load of circuit, and the 50-volt secondary is connected in series with one side of the feeder, and the primary (1,000 volts) across the two sides, the 50 volts will be added to the 1,000 volts of the mains, raising its pressure 5 per cent. Adding a number of transformers in series thus, with switches to throw them in or out, makes a convenient way of raising the voltage of feeders. Choking-coils may be employed instead of "boosters"—only in using them they will be placed on feeders of light load, and the dynamo voltage raised by increasing the speed. The first cost is in favour of "chokers," but maintenance cost is in favour of "boosters." A serious annoyance is sometimes met with from the inductive effect of two long parallel circuits, causing the lamps to waver or "pump." The engine is generally blamed, but it may occur from the inductive effect of a circuit carrying a heavy current on a circuit carrying a light load, on the same principle as a transformer; and where fed from separate dynamos the phases will not correspond, so that pumping results. It may be cured by transposing the circuits. Mr. Sterling's experiences are interesting, and we hope we shall have more like them, dealing with every kind of practical points met with in alternating-current working.

Electric Smelting and Casting.—Mr. George Ambrose Pogson, the British Vice-Consul at Hamburg, explained to a number of gentlemen who visited him at the Wharncliffe Hotel, Sheffield, on the 9th inst., the "Taussig" system of smelting and casting metals in exhausted chambers. The system is claimed to produce, by a single process, every 15 minutes, with an expenditure of 360cwt. of coal per 1,000cwt. of finished cast metal, bronze, iron, steel, copper, brass, zinc, platinum, gold, or silver, free of pores or bubbles. The process is effected by electricity by means of flat metal electrodes in an exhausted furnace, large moulds being set up outside the furnace, and exhausted by one process simultaneously with the exhaustion of furnace. Castings up to 30lb. of iron have been made in the presence of her Majesty's representatives at Hamburg within 15 minutes, the air-pump in use showing 92 per cent. exhaustion of air; ampere-gauge, 2,500; voltage, 2½ volts. The electric current does not effect its work from outside through surface of crucible or furnace, but by conduction through the metal itself which is about to be smelted. Siemens-Martin steel is fused without any other parts of the electric current undergoing any material increase of temperature. By use of metallic electrodes all contamination of metal by carbon is absolutely avoided, as coal slack is not present in any large quantity, refuse is reduced to a minimum, and oxidisation and creation of air-bubbles are, it is contended, by this new method of smelting in a vacuum, by means of removal of carbonic acid gas, etc., also avoided. The metal becomes more liquefied, and, on account of the casting forms being denuded of air, permits of extremely close and fine casting, even of objects of excessively small diameters. Amongst other pertinent justifications for these assumptions is the fact that the samples which have up to the present been tested in the proof-rooms of the Royal Technical School at Charlottenburg, near Berlin, have, notwithstanding the prejudicial circumstances under which they have been produced, according to a copy of the Government report in regard to such tests, shown very satisfactory results. From the nature of the system adopted it ensues that the electric force which is carried out with currents of great strength, but low voltage, is attended with absolute freedom from danger. Small iron propellers and similar objects are constantly melted and cast at Bahrenfeld in the presence of witnesses within a period of 12 to 15 minutes. Currents of 20,000 to 30,000 amperes are no exaggeration, and exhaustion of air from the largest chambers now presents no difficulty. By the employment of 30,000 amperes and 50 volts a force equivalent to about 2,000 h.p., or somewhat less than that used by the aluminium works at Neuhausen, on the Rhine, the casting form would have a minimum length of 12 metres, and a width of 1½ metres. This would give a body of metal of 180,000 cubic centimetres, or about 1½ tons. According to the experience gained in experiments at Bahrenfeld, such casting would be effected in one process lasting in all not longer than a quarter of an hour. The expenditure of coal is, therefore, in round figures, but 50 per cent. of that necessitated by the most perfect system at present in use. The use of water power naturally increases these advantages in an enormous extent. The iron furnace seen by Mr. Pogson at Prof. Taussig's works at Bahrenfeld consisted of a rectangular vessel, 6ft. by 3ft. by 3ft. Two electrodes, apparently of wrought iron, were placed upright inside the furnace, so that their surfaces of 8in. by 4in. faced the arc-shaped piece of iron which was to be fused; a channel of clay served the purpose of conducting the fused metal from its clay melting bed into the empty clay mould of a model propeller, the mould in question being placed at a lower altitude in the other empty iron furnace. The wires connecting the flat metal electrodes with the powerful generating machinery put up by Messrs. Schuckert and Co., the well-known German electrical engineers, were already in position, as was also the exhaust pipe connecting the furnace with a steam air-pump of about 20 h.p., which also drove the dynamos. Having personally placed the 30lb. of pig iron in the clay bed, placed parallel with, but a few inches in front of, the flat electrodes, the cover of the oven was swung on; the necessary exclusion of external air being effected by indiarubber pads fastened to the furnace cover. Punctually at noon the cover was fastened down, and the pump set working, the current being switched on at the same moment. The indicator of the exhaust pump soon showed an exhaustion of 92 per cent. of air. The electric indicators showed respectively 2,500 to 3,000 amperes and 2 to 2½ volts. The gradual approach from red to white heat could be followed from the eyelets in the furnace. Fusion was obtained at about 12:8, the indicators showing great unsteadiness until the resistance had been reduced to nil by the current being allowed to pass freely through the fused metal. At 12:14 the furnace was opened, and a minute or two later the clay was being chipped off and the perfect cast of a propeller was exposed to view. Mr. Pogson strongly advised the despatch of technical men to Hamburg for the purpose of examining the process. He also promised to try and reply to any scheduled technical questions which might arise from his description.

ELECTRIC TRACTION AND GEARING.

We have several times called attention to the waste which occurs with all systems of electric traction, as a consequence of the great demand for current for starting a car or train, and in some cases for hill-climbing. Prof. Forbes called attention in our impression of the 6th of January to the effects of this on the motors in the States and elsewhere, one result of these being that it has become common to use a 30-h.p. motor on a car so as to avoid destruction of armatures, but to do an average of only about 10 h.p. or less. At the recent meetings of the Institution of Civil Engineers, and in the discussion of the paper on "Electrical Railways" by Dr. E. Hopkinson, Mr. Greathead, the engineer of the City and South London line, placed before the meeting a number of diagrams and load curves showing how great is the waste consequent upon the great demand for current for starting the trains, a demand which makes it necessary to provide, and to keep at work at an uneconomical load, generating plant much greater in power than would be necessary if it were not for this waste.

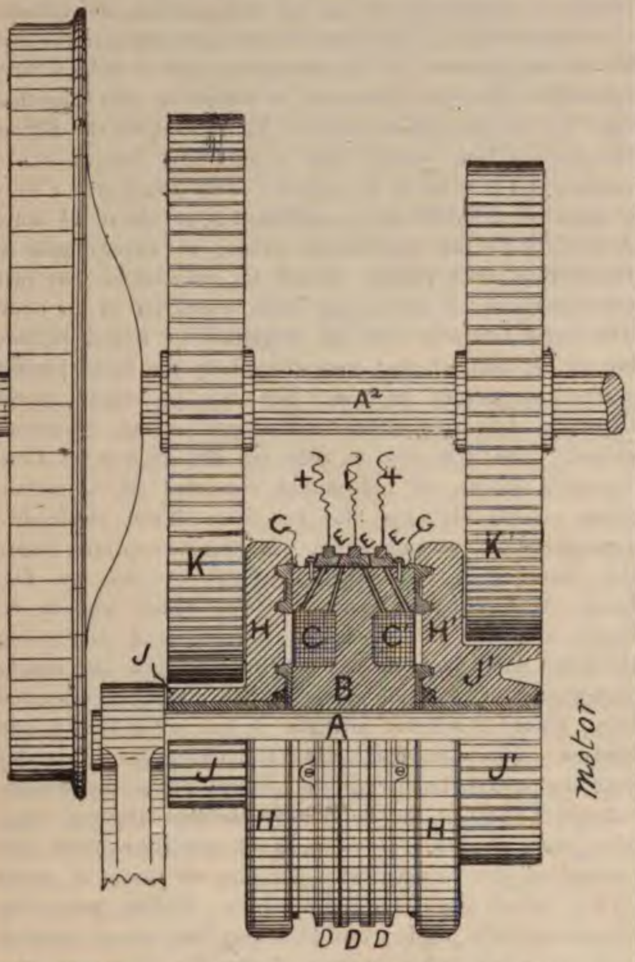


FIG. 1.—Beaumont's Single-Reduction Variable Speed Gear.

It has long been recognised that if a satisfactory means could be obtained for mechanically varying the relation between the speed of the motor and the car or electric locomotive, so that the start could be gradually made, or so that heavy gradients could be mounted at a slower speed, that this source of loss could be avoided. It is certainly very far from creditable to engineering skill that it should be necessary to put a 30-h.p. motor on a two-horse car, and not only to put the 30-h.p. motor on the car, but to provide current-producing or generating plant, engines, and boilers in the central station to supply the 30 h.p. of current to that two-horse car when it wants to start, though that same plant may be nearly idle for 60 per cent. of its time. This, however, at present is the way of getting over the difficulty of burnt armatures, which are very common when motors of anything like moderate power, say 15 h.p. for a two-horse car, are used. There seems, however, a prospect of the removal of the difficulty, and the means of doing it were described at the institution last week. In the course of the discussion Mr. W. Worby Beaumont referred to this subject, and he described the forms of gearing which we illustrate—one for motors driving cars by single-reduction gearing, and the other for direct-driving motors. These represent two of several forms of gear which he has devised for cars, electrical lifts, cranes, and other electrically-operated machinery.

Fig. 1 shows the arrangement of gearing, partly in section, for electric tramcars. In it, A represents a motor shaft and A^2 a car axle, arranged as for single-reduction gearing. On the motor spindle is fixed a double-faced disc magnet, B, current being sent into either of the two energising coils, C and C^1, through the medium of the conductors, + +, and the return conductor, –, according to which side of the magnet it is desired to use. On either side of the double magnet are pinions, J and J^1, connected to the armatures, H and H^1, the pinions running loose upon the shaft of the motor and gearing with the wheels, K and K^1, the one or the other as may be desired. In starting a car, current would be sent through the coil C by the conductors, + –, and a brush, E, resting upon one of the collector rings, D. The armature H would thus be drawn to and held by the magnet, the frictional hold being increased by the use of the pole-pieces or rings, G, with annular projections fitting into grooves in the armature. The small pinion, J, will thus be fixed to the magnet and thereby to the motor shaft, and the car axle, A^2, will be driven at a speed corresponding to the ratio subsisting between the diameter of the pinion J and the wheel K. This in the diagram is a ratio of 4 to 1. The cars, having been started or having ascended a hill by this means at the slow speed, the motor running at full speed, may now be driven at the higher speed due to the larger pinion, J^1, and smaller wheel, K^1, by cutting the current out of the coil C and sending it through the coil C^1. The armature H is thus allowed to run loose upon the motor spindle, and the armature H^1 is fixed to it, and the car will now be driven at the higher speed. This, in the case shown, would be double the lower speed.

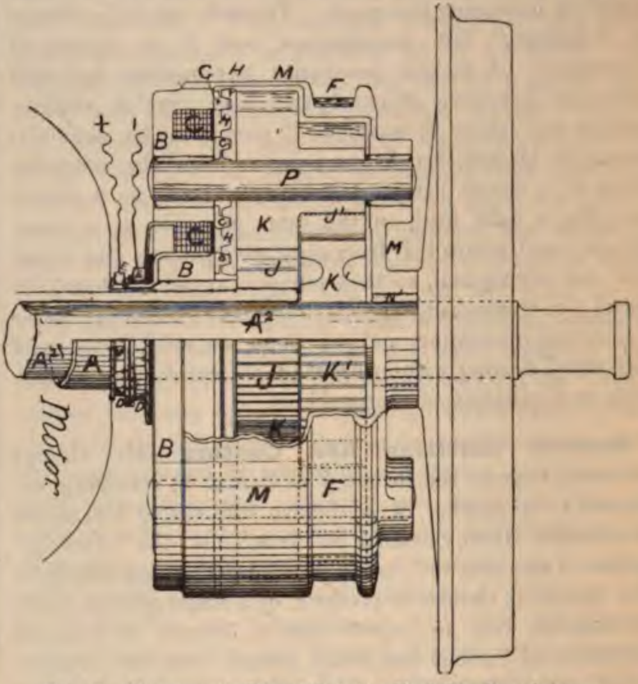


FIG. 2.—Beaumont's Direct-Driving Variable Speed Gear.

An arrangement of gearing for attaining the same end with direct-driven cars or railway axles is shown in the other diagram, Fig. 2, partly in section. In this case the maximum speed is that of the motor, the shaft of which, A, is hollow, and is mounted and runs upon the shaft to be driven, A^2—namely, the car or railway axle. Upon the motor shaft, A, is fixed a pinion, J, gearing into an idle wheel, K, carrying a pinion, J^1, which gears into the wheel to be driven, K^1, fixed to the shaft, A^2. Fixed upon one face of the idle wheel, K, is an annularly-grooved disc armature, H, into which the rings, G G, on the pole-pieces of the disc magnet, B, fit, forming a magnetic clutch. Two such clutches are employed in the arrangement shown. Current for energising the coils of these magnets is supplied through the conductors + –, the brushes, E, and collector rings, D. By means of these magnetic clutches so formed, the idle wheel, K, and the connected pinion, J¹, may be held fast, and when this is done the shaft, A, of the motor, the whole of the gearing, and containing case are locked together, so that the speed of the driven shaft becomes that of the driving shaft. For starting an electric car or locomotive, current is cut out of the coils of the magnets, B B, and is instead directed into a magnetic clutch break, not shown in Fig. 2, except in so far as the clutch-break band is shown in section at F upon a part of the case M, which is made circular for the purpose. When this clutch break, F, is in action, the case, M, is held fast, and the idle wheel, K, revolving with the spindle, P, drives the car axle, A², at a speed which is proportional to the dimensions of the gearing. In the example shown, the motor shaft, A, would make 2½ revolutions to one revolution of the car or locomotive axle, A². It will be seen that for ordinary running—that is to say, after starting, and when not climbing a hill—the whole of the gearing is inactive.

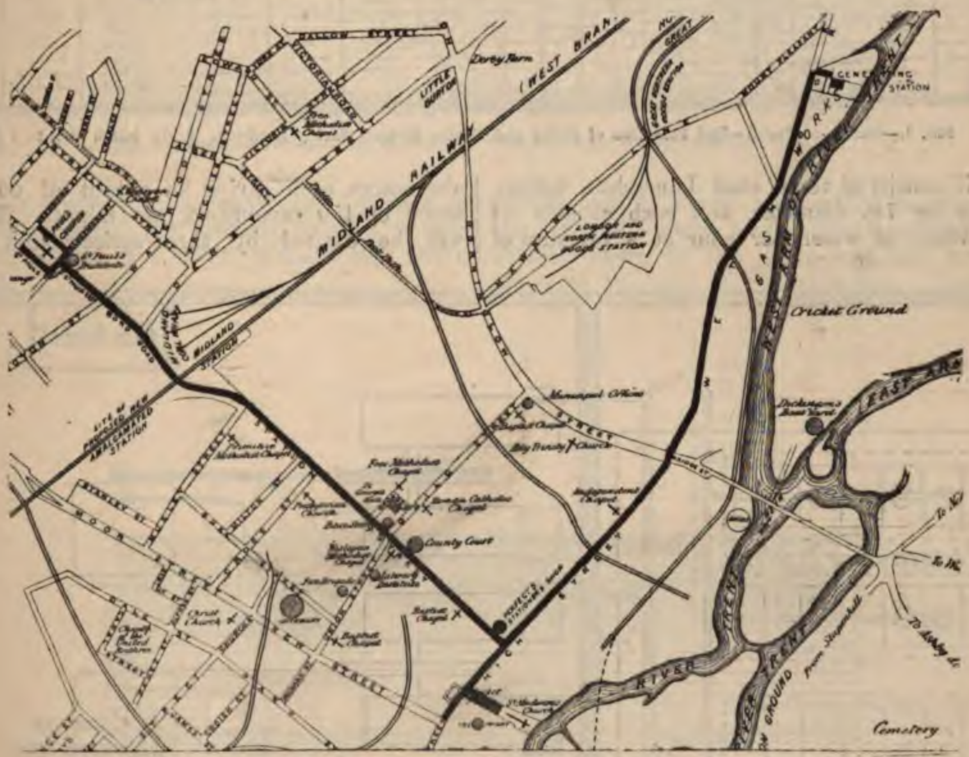
THE PROPOSED MUNICIPAL ELECTRIC LIGHTING SCHEME FOR BURTON-ON-TRENT.

BY H. WARING.

In common with many other municipal bodies, the Corporation of Burton-on-Trent, who, by the way, owns the existing gasworks, has wisely determined to retain for itself the powers conferred by its electric lighting provisional order obtained in 1890, and, in all probability, within the next month or so the foundation-stone of the generating-station buildings will be laid.

The area of supply included in the provisional order embraces the whole of the municipal borough, but the compulsory area includes only a few of the principal streets in and about the centre of the town. In the first instance it is only intended to lay mains in the compulsory area with the exception of a distance of about 400 yards—viz., from the Midland Railway Station to St. Paul's-square—which lies outside this area; the streets in which mains will be laid for a first supply being as follows: Wetmore-road as far northwards as the generating station, High-street, Market-place, Station-street, Borough-road, St. Paul's-street East, and St. Paul's-square—a total length of about 3,400 yards. The generating station will be situated adjoining the north boundary wall of the gasworks, on a plot of land which is some three-quarters of a acre in extent, that has been leased by the Corporation from the Marquis of Anglesey for a term of 99 years. The site chosen for the works is rather an inconvenient one, considered from the point of view of capital outlay on mains, as it will occupy a rather one sided position with respect to the area to be supplied, both now and in the future; also for a distance of about two-thirds of a mile from the generating station there is very little probability of any demand for current arising, at least for many years to come. The present site was, however, selected partly in consequence of no very suitable piece of land being obtainable in a more central position, and also that by having the generating station adjoining the gasworks working expenses would be somewhat reduced, and great facilities offered for the supply of fuel, removal of ashes, etc., as it is proposed to extend the existing railway siding at the gasworks right up to the boiler-house of electric-light station.

The buildings for the generating station, views of which are given in Figs. 1, 2, 3 and 4, have been designed, and the drawings prepared at the gasworks, under the superintendence of Mr. Ramsden, the Corporation gas engineer, who has been assisted by the writer. The buildings comprise boiler-house 60ft. long by 45ft. wide by 24ft. high to eaves, and engine-house 60ft. long by 64ft. wide by 24ft. high to eaves. Both of the above will be substantial plain brick buildings, no attempt at ornamentation having been made. The foundations for the walls, engines, dynamos, feed-water heaters, boilers, etc., will all be, as far as at present known, 12ft. deep, and formed of solid concrete, and the buildings, including chimney 60ft. high, will, when complete, cost about £3,500.



Burton-on-Trent Electric Lighting.—Map of District.

The switch-room, test-room, engineer's office, and a small store-room will be placed along the inner side of the west wall of engine-house, whilst a mess-room for workmen, lavatory, etc., will occupy part of the length of the south gable.

Turning now to the generating plant. Tenders to a general specification were invited by the Corporation in July, 1891, and in response 17 firms sent in estimates, and after mature deliberation, and a visit (as per usual in the case of municipal bodies) by a deputation to various places where electric-light stations existed, the Council unanimously decided to adopt the high-pressure alternating-current system, and ultimately accepted the joint tender of Hammond and Co., and John Fowler and Co., Limited, subject to the approval of their system by the Board of

Trade, whose approval in course of time was duly received. The plant which will be put down in the first instance will be for supplying energy for 3,000 16-c.p. lamps, and will be divided into three units, each unit plant being capable of supplying 1,000 lights.

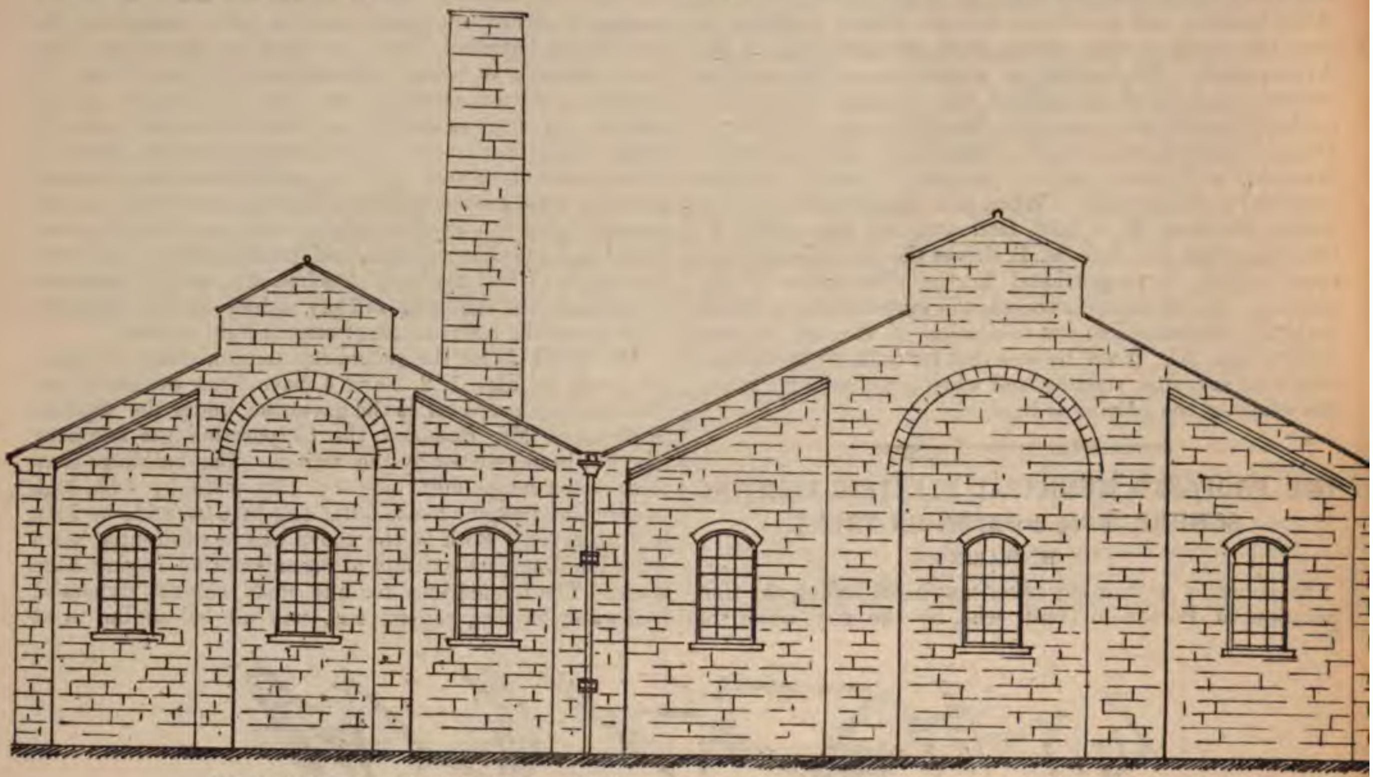


FIG. 1.—Burton-on-Trent.—End Elevation of Boiler and Engine Houses, Facing Roadway. Scale, 1-16th inch to 1 foot.

The plant will consist of three steel Lancashire boilers, each 26ft. long by 7ft. diameter, and each capable of evaporating 3,300lb. of water per hour at a pressure of 100lb. per square inch. These boilers will be fitted with Perret's patent forced-draught furnaces, by means of which it will be possible to utilise as fuel a great part of the refuse of the gasworks. The boilers will supply steam through a ring main to three coupled compound horizontal non-condensing engines, each of 106 b.h.p., with a pressure of 95lb. in the steam-chest of the high-pressure cylinder, and at a speed of 90 revolutions per minute. The flywheels of the engines will be 12ft. in diameter, and grooved for six 1½in. diameter cotton ropes, by means of which will be driven three Lowrie-Hall alternators, each giving an output of 66 kilowatts, at a speed of 450 revolutions per minute. These alternators will be excited by three series-wound drum armature exciters, each driven by means of 4¾in. cotton ropes from shaft of alternator.

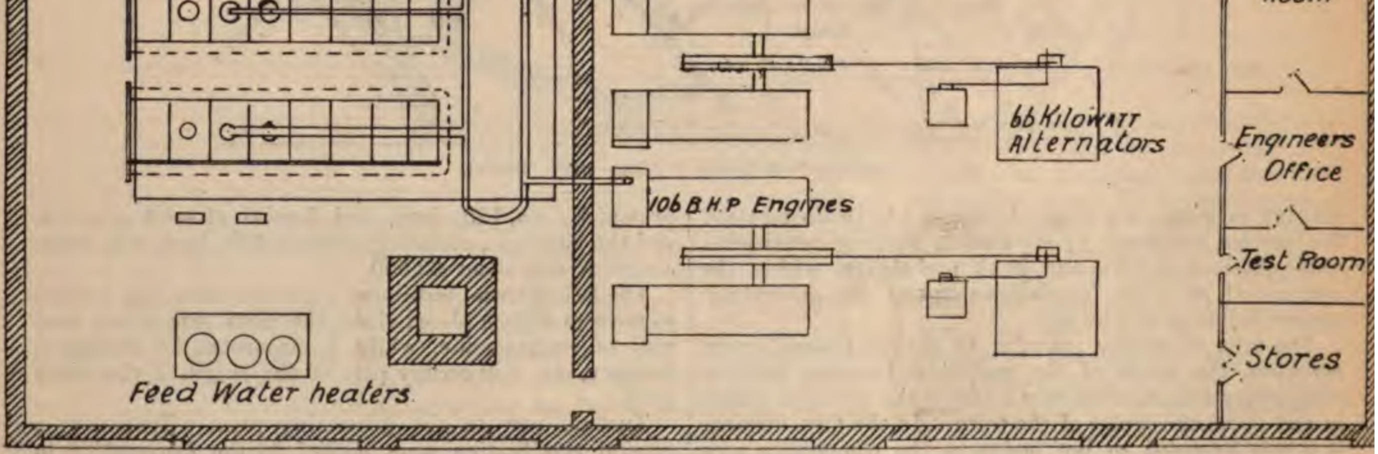


FIG. 2.—Burton-on-Trent.—Plan of Boiler and Engine Houses. Scale, 1-16th inch to 1 foot.

As before mentioned, the three boilers will supply steam to a ring main, from which branches will be taken to the steam-chests of the high-pressure cylinders of the engines. The exhaust steam will be discharged up the chimney, and on its way thereto will pass three feed-water heaters, these heaters being so arranged that the exhaust steam can be sent through any one or all of the heaters, or pass them as desired. The feed-water will be taken by means of two steam-pumps from a wrought-iron water-tank, capable of holding 5,000 gallons, which it is intended to erect in one corner of the boiler-house, at a height of about 14ft. above the ground level.

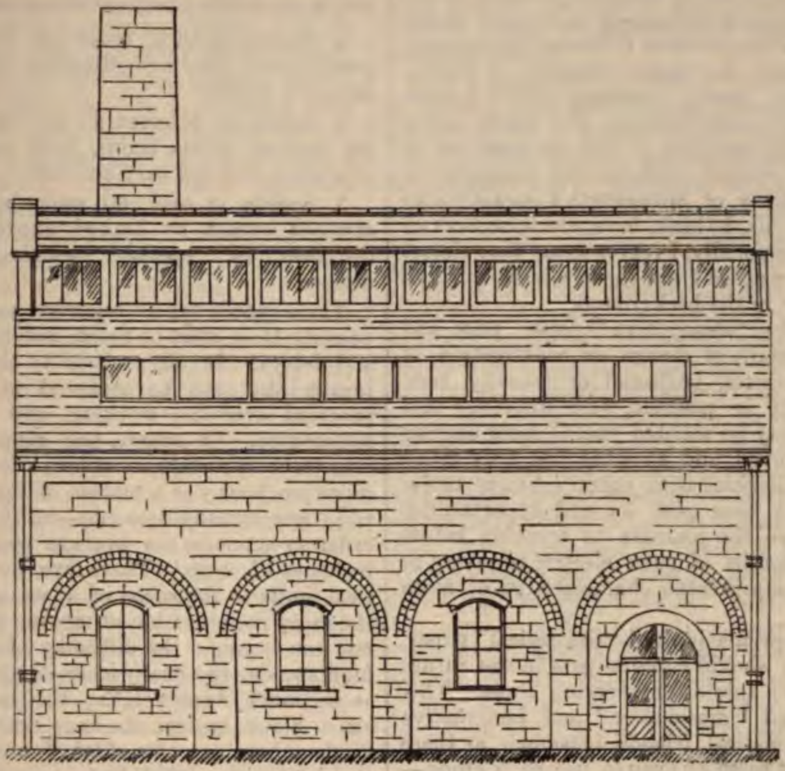


FIG. 3.—Burton-on-Trent.—Side Elevation of Engine House. Scale, 1-16th inch to 1 foot.

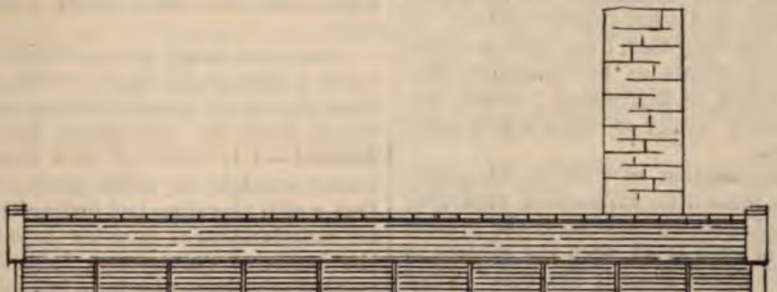


FIG. 4.—Burton-on-Trent.—Side Elevation of Boiler House. Scale, 1-16th inch to 1 foot.

The system of distribution which it is intended to adopt is as follows: Two high-pressure mains will leave the generating station, one of $^{37}/_{14}$ will be laid along the Wetmore-road, High-street, and Station-street as far as the Midland Railway Station, the other, $^{37}/_{15}$, will be for supplying St. Paul's-square end of district, and go along the Wetmore-road, High-street, down Station-street, Borough-road, and St. Paul's-street East, to St. Paul's-square. At suitable intervals along the line of these high-pressure mains, determined by the probable demand for current, will be placed Lowrie-Hall transformers, buried in the ground, which will transform the high-pressure current down to 100 volts, and feed into low-pressure mains of $^{19}/_{15}$ and $^{19}/_{14}$ respectively. These low-pressure mains will extend over the whole of the area to be supplied. Both the high-pressure and the low-pressure mains will be of the best Silvertown make. The price which it is first intended to charge is 8d. per unit, but no doubt as business extends the Corporation will see their way to reduce the price.

THE POSSIBILITIES OF HIGH-SPEED ELECTRIC TRACTION.*

BY FRANK B. LEA.

Most, if not all, of the papers or subjects brought before the members of this society would appear to be such as can be treated from one or other of three different standpoints. We may have, for instance, the highly scientific or mathematical discourse upon theory bristling with figures, formulæ, and facts that might without any doubt prove of great advantage to the engineer, if only he could get at them when they are wanted without the necessity of carrying an assorted library of Molesworth's pocket-books on his person. Most of us, I think, have reminiscences of papers after this kind; personally, I regret to say that almost the only benefit which resulted from them was due to the brief rest of forty winks in the background.

Secondly, there is the "descriptive" paper pure and simple, in which the details of design or construction of some engineering enterprise, projected or actually completed, are given as fully as possible, with drawings and diagrams, from which may be collated useful facts bearing upon the principles involved, and showing not only many differences, but also similarities with other schemes under varying conditions. As time goes on, and opportunities increase, I hope to have the pleasure of bringing before you in this way the details of such electric tramway or railroad enterprises as may present characteristics of more especial interest.

Thirdly, there is the speculative and "theoretical" paper, concerning what may or should come to pass in the future in connection with some special engineering topic. This type may be considered "moonshiny" and imaginative by some of our mathematical friends, inasmuch as there are few or no facts to set forth, or even to use as a guide—the field is fresh and untrodden, and one is only too apt to go astray. And yet the road for new developments can be opened up in this fashion more easily than by any other method, since not only is the general course of thought and inventive ability thereby trained by a mass of experience already acquired, but when practical results are aimed at one may reach them sooner by clearing the way as far as possible, showing what extensions are consistent with our present knowledge, and what appear unlikely. It is a speculative paper of this kind that I am going to inflict upon you, embodying such efforts as have already been made to gauge the possibility of high-speed traction, and the superior claims of electric energy as the tractive agent employed for the purpose.

That brings me to the question of title to this paper, and I ought first to make some little explanation regarding same. It is certainly impossible for anyone at the present time to deal adequately, or even at all, with the subject of "The Possibilities of High-Speed Electric Traction," when such a method of transit is absolutely non-existent. We speak of the possibilities of steam locomotion, or of electric lighting, because these are matters of everyday experience, and it is easy to discuss their development, limits, and conditions. It is, however, hardly proper at the very outset to attempt an investigation into the limits or possible conditions of high-speed electric traction until we have at least some slight knowledge or actual experience thereof. I prefer, therefore, to put the second word of the title in the singular number instead of the plural. The "possibility" of high-speed electric traction is a matter we can all talk about, and theorise upon, with the help of such facts as are available.

After discussing the question of its "possibility," the "probability" of this method of traction may then be presented as a matter for further deliberation; and it is only after getting a satisfactory answer to this point that we can, in the future, spend time and trouble with profit in discussing and finding out the limits and fundamental conditions of electric traction according to the experience we shall then have gained.

The whole question, of course, turns first of all upon the exact meaning which we choose to give to the phrase "high speed." In 1823 a speed of 15 miles an hour was considered high enough for anybody, but in 1893 we have gone up to four times that velocity as the representative high speed. Taking the subject of traction in general, there are at present perhaps three great divisions of speeds into which the traffic upon our steam roads may be separated:

1. Speeds up to 25 miles per hour, including nearly all goods trains, local and suburban trains, and the main-line stopping trains.

2. Speeds of between 25 and 60 miles per hour, including express goods trains, local and main-line passenger expresses, and ordinary specials.

3. Speeds of over 60 miles per hour, a rate seldom attained except by limited expresses running over long distances, or "special" specials under favourable conditions.

These speeds are all regarded as representing the average velocity from start to finish, and therefore include all stops and delays. In all probability they represent the utmost results that can be achieved on our steam railroads in practical everyday working, and as they are at present constituted. Of course, one cannot say that a locomotive or a train is unable to attain a far higher speed than 60 miles per hour; as a matter of fact it will often require to run—and actually does run—at 70 or 80 miles per hour in order to maintain an average speed of anything over 60, inclusive of stops. There are, however, well-known practical limits to the speed of a steam locomotive and train: the rapid reciprocation of moving parts on a rail foundation not too secure; the difficulty of clearing the exhaust at high speeds; the heavy loads of coal and water to be carried as so much dead weight; the necessity for observing a strict block system on lines crowded with traffic of all kinds—these are the chief, if not the only, reasons why steam traction cannot hope to carry either goods or passengers at a materially greater speed than is now done, other things remaining the same.

The question then arises: If steam has thus apparently reached the limit of its usefulness, are we to go on with it contented with slight improvements from time to time, or will the demands of the travelling public for continually increased speeds become so urgent that the help of some agent other than steam power must be immediately sought out?

There are many who consider that even to-day there exists a demand for rapid transit at speeds much higher than that of our present railway expresses, and if we are to reason from the analogy of the past half century, this demand—if it does not now exist—will very soon grow strong enough to make great improvements necessary. One would therefore feel inclined to appeal for a very careful consideration of possible high-speed electric transit at the hands of railway men in general, but perhaps more particularly those who have helped in the mechanical work that has developed James Watts's tea-kettle into the "Greater Britain." It may be, however, that my assumptions will be questioned by them, yet—for the adequate discussion of the subject—it is necessary to make at least two—viz., in the first place, that the limits of speed for steam locomotives have practically been reached by our present express traffic; and secondly, that travellers are beginning to desire still greater speeds as nations and countries come into closer touch with one another, and find more rapid inter-communication to be a growing essential of modern life. Assuming these statements to be fact, the subject we have to discuss is somewhat as follows: Does electric energy, in the first place, offer superior mechanical advantages for high-speed traction as compared with any other conceivable method; and in the second place, are these advantages obtainable at a comparative expenditure (both on capital account and maintenance) that will justify the employment of electricity as the tractive agent? It is only after obtaining satisfactory answers to these two questions that we may consider high speed electric traction to be possible from a common-sense point of view, since no one would trouble to put into practice a system which might show on the face of it that the extra cost would not be counterbalanced by the value of its greater advantages.

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* Paper read before the Owens College Engineering Society, March 14, 1893.

It should be said at the outset that electric traction will probably not do more in its present condition—so far as high-speed transit is concerned—than serve to convey extremely light loads, such, for instance, as express passenger traffic. The cost rendered necessary for the initial outlay and early maintenance of any such scheme is so great that only the best-paying loads would at first be admissible; and the day is yet far distant when coal, iron, fish, timber, cotton, wool, and all the other merchandise of the country will be towed along by chained lightning. It is doubtful even whether electricity would care at the outset to rob the railways of that blessing in disguise (if they only knew it)—the parliamentary train. The problem therefore resolves itself into a consideration of electric energy as employed to propel trains at an average velocity of, say, 120 miles per hour, as compared with the average of 60 now attained as a maximum by steam locomotives. There is not, of course, in existence to-day a single solitary line where this speed is or can be obtained by electric traction; we can therefore only theorise from the knowledge and experience already acquired in electrical work as well as from steam railroading.

Let us note the different conditions essential to electric rolling-stock as compared with what is employed on steam roads. First and foremost, we get rid of all reciprocating motion at once: the rotating armature of the electric motor is mounted directly upon the car axle without any intermediate gearing. It is interesting in this respect to see how much the enclosed or fenced-in high-speed electric railway is superior to the electric street tramway, and judging from the success of the latter when properly erected and worked, there ought to be a still greater chance for the prosperity of high-speed electric lines. The tramway is tied down to a speed of at most 10 miles an hour; the motors employed are of comparatively small size—say, 15 h.p. each—and their armature speed, or number of revolutions, will therefore be high. Yet this high speed of rotation—which almost appears to vary inversely with the power—must be reduced to a slow speed on the axle, and gearing of some kind therefore becomes necessary. A normal speed for ordinary motors of 15 h.p. to 17 h.p. seems to be about 1,200 revolutions, though, of course, a special design of machine will give slower speeds than this with proportionally increasing weights. It is not desirable to carry too much dead-weight, and the tramway engineer has therefore to hit the happy medium between excess in weight and excess in speed. In any case, however, it is pretty certain that motors coupled directly to the tramcar axles, without the intervention of gearing, would be very inefficient.

Taking the diameter of car wheels to be 28in., and the maximum speed 10 miles per hour, the axle revolutions are 120 per minute, so that a 10 to 1 gearing is necessary with the ordinary motor. With fast-running trains, however, on an enclosed line, not only does the axle speed increase, but the armature revolutions per minutes become less, almost in proportion to the greater power required from the motor, so that a point is reached at which the two speeds coincide, and the armature can then be mounted directly upon the car axle.

Take, for instance, a 95-h.p. motor of ordinary design, the speed of which would be, say, 700 revolutions per minute. A car with 6ft. driving wheels would give at a velocity of 150 miles per hour exactly the same speed; or take—as is proposed for the rapid-transit line between St. Louis and Chicago—motors of 200 h.p. with armatures running at 500 revolutions per minute. If these motors are mounted on car axles, with driving wheels 7ft. in diameter, a speed of 120 miles per hour would be attained by their use.

This great adaptability of electric motors to a direct coupling, or mounting upon the driving axle when run at high train speeds, or with considerable output, is shown even at such a low velocity—comparatively speaking—as 30 miles per hour. The electric locomotives to be employed in carrying the Baltimore and Ohio main-line traffic through the long tunnel, now in course of completion under the former city, are to have 5ft. drivers, with motors mounted on the axles, running at 170 revolutions per minute. An output of at least 1,500 h.p. is specified, so that a speed of 30 miles per hour may be maintained even on up grades.

Some emphasis may, I think, be properly laid upon these details, if only to show the advantage in high-speed electric traction of doing away with the inefficient and wasteful gears that are essential to slower traffic, but which do not, however, seem to prevent the latter from reaching a practical success.

Such a possibility as that of obtaining a rotary torque, or turning movement, acting directly upon the car axle, not only gives a steady motion instead of the alternative jerks of a reciprocating piston-rod, but also obviates at once the necessity for a locomotive at all. In fact, the engine and tender—with their heavy weights of iron and steel, coal, and water—are abolished instanter, as part of the dead-weight of the train.

Instead of taking place at all times on each engine, the generation of power is transferred to a fixed station, the details of which will be gone into by and by, and the locomotive with its tender, mounting up to at least 50 tons (and probably nearer 80 tons) in weight, only one-third of which may perhaps be available for adhesion purposes, is replaced by electric motors of great efficiency, every ounce of whose weight acts beneficially in the way of spreading the adhesion weight throughout the train. Not only is the weight more evenly placed in this manner throughout the train, but it is possible to obtain a greater proportion of driving wheels, and therefore a much steadier motion both at starting and when running. The adhesion weights and the points of applying the driving power are better distributed in an electric train than on a steam road. As an instance of this may be cited the Caledonian express engines, running the Scotch traffic between Carlisle and Edinburgh during the race five years ago. In working order, engine and tender weighed 75 tons loaded, and the average train about 146 tons additional, or a total of, say, 221 tons. Out of this only 17 tons, or one-thirteenth of the total weight, were available for adhesion, the engine being a single driver with 7ft. wheels.

Compare this with the Liverpool Overhead Railway, where the motors are mounted directly upon the car axles, so that the whole of the weight is available for adhesion: out of the total weight of, say, 40 tons for each train of two cars, probably six tons would represent the weight of the motors. This is nearly one-sixth of the total, and is twice as much in proportion as with the Scotch express. With a current of 80 amperes, indicating about 50 h.p. each, these motors would have a torque of about 1,000lb., or, say, one-sixth the adhesion weight, so that there would be no fear of their slipping. It is doubtful whether the steam locomotive would start or run uphill without a continual use of the sand-blast: for taking the mean effective cylinder pressure to be 120lb. per square inch, the tractive force would be nearly one-third of the available adhesion weight. So far, then, as concerns these very important mechanical qualities, the use of electric traction appears to offer advantages much superior to anything that can be brought forward by steam locomotion in its best forms. When, in addition, we remember that even an engine with single drivers must have at least fifteen or twenty principal working parts which are constantly being worn away—pistons, cross-heads and guides, cranks, eccentrics, valves, and main bearings—whilst the number of wearing surfaces in an electric motor amount to just four—the main axle bearings and a couple of brushes on the collector—it is evident that the not inconsiderable item of power wasted on engine friction alone is reduced to little or nothing when we employ electric energy as the tractive agent. It is a matter of comparative ease indeed to do away altogether with the two brushes that bear upon the collector or commutator, by employing a motor suited to alternating currents; in this case the sole wearing surfaces would be the main axle brasses, and these we can hardly avoid just yet.

The friction between the current collector on the electric train and the line conductor with which it makes a sliding contact, is so small as hardly to be worth notice. No pressure at all is exerted at the points of contact, over and above the few pounds' weight of the cast-iron collector.

(To be continued.)

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WOODHOUSE AND RAWSON.

Events travel swiftly, and barely had the committee of investigation made public their report last week when the debenture-holders took action and a receiver was appointed. A meeting of shareholders is to be held on the 20th inst. to consider resolutions in favour of voluntary liquidation and reconstruction. The time has come when perhaps a little more plain speaking is necessary. A consideration of the committee's report, and of the directors' comments thereon, as well as a careful perusal of the various balance-sheets, not to speak of the history of the company, will cause men to hesitate before sanctioning any scheme of reconstruction proposed by the directors. If ever there was a company's affairs that required the full fierce light of legal investigation thrown upon them, this is surely one. The last balance-sheet shows that the directors had received in cash for shares and debentures, in round figures, £600,000 (£591,043. 12s. 6d.). We commented upon this balance-sheet at the time, and argued that the concern was rotten to the core. Fancy a company of three years' existence, with an industrial branch turnover in the respective years of £72,258, £126,015, and £151,121, putting goodwill down as worth £99,263. 3s. 7d., or the value of paper investments in subsidiary companies —mostly, if not entirely, promoted by themselves— as £101,847. 5s.! Whatever we could say would be mild compared with the terrible array of indictments brought forward by the committee. A singular feature in the whole affair is that the vendors got £75,000 on certain conditions. These conditions were fulfilled—the committee say not satisfactorily—and then the gigantic concern comes smash. But the payment of the £75,000 to the vendors involves another question. According to the balance-sheet, the amount of debenture stock is £98,562, and of debenture bonds £65,500. Now £51,000 of the £75,000 was taken in debentures, so that of the debenture stock the vendors by taking this amount hold a controlling influence. Had there been no bonds, which we take it rank exactly as stock, these vendors could at any moment, under the circumstances which have all along existed, taken control of the whole concern. But we have much wider grounds of attack upon such concerns. An enormous damage is done to the industry generally. Here is a concern ostensibly founded for industrial purposes. As soon as money is obtained, the directors, instead of pursuing steady business and developing trade, plunge recklessly into company-promotion, waste the substance of the shareholders upon "castles in the air," make up profits with paper shares the real value of which is utterly unknown. We are told about the hopes and fears of the Elmore Companies, of the Okonite Company, but what is the truth about these concerns? The Elmore Companies have run through all their money and want more, without having which we are told they cannot well succeed. Of what value, then, is the "paper" of these companies? It is admitted also that the shares in Okonite have depreciated, but that the debentures produce a safe return. We now know as a fact, from the committee's report, how the "profit" balances were obtained, but there is much that the committee do not and cannot tell us. There has been some industrial work, and some trading business. Installations have been obtained and carried out. We ask at what price? Has a profit been realised? Has good work been done, or have these installation orders been taken at cutting rates and resulted in losses combined with scamped work? The surmise that this has been the result is but natural, and if correct, who can trace the harm done? Business is taken by a declining company at any price. Efforts are made to look as if a large business was doing, in order to induce other men to advance money. Those who do good work and produce apparatus that will stand the test of wear and tear are put aside, because buyers look more at "price" than anything and expect a company that poses as having a reputation to do good and creditable work. The creditors and shareholders are to be asked to rehabilitate the company, and, we suppose, put its future into the hands of those who have wrecked its past. The shareholders may do this, and they may not; we presume they won't. They have lost the money put into the concern, for by no stretch of the imagination can they expect it to be recovered.

Might we venture to suggest that, if it can be proved legally that the various balance-sheets were improperly constructed and the 15 per cent. improperly declared and paid, it may be possible to recover the £75,000. Assume, for example, that the £51,000 debentures still exist, and that the directors implicated hold £30,000 to £40,000 shares. Is the law able to cancel the debentures and confiscate the shares to the amount misguidedly paid? The cancelling of £51,000 of debentures would make a vast difference to the liabilities of the company. We await further developments of this concern with considerable interest.

THE TELEPHONE COMPANIES.

Our contemporary practically coincides with our view, that discussion upon any question is unlikely to do good unless the arguments proceed from agreed fundamentals. With the exception of the *Electrical Review*, we imagine that it has been customary in this country at any rate to distinguish the "Law" and the "Mann" systems as being independent. Telephonic literature is not very extensive, but *Preece and Maier*, chap. xviii., p. 298, describe the "Law" system, and p. 302 describe the "Mann" system as "a modification of the Law system." On pp. 306, 307, diagrams of the "Mann" and "Law" systems are given, showing at a glance the difference. *Poole*, in his excellent little book, follows the lines of *Preece and Maier* on this point, similar diagrams being used in the description of the two systems. *Allsop*, second edition, p. 227, also describes the "Law" system, and p. 229 the "Mann" system. (Unfortunately, Mr. Allsop, as our American cousins would say, is still in a state of barbarism as regards a good "index." He has something which he calls an index, but as for its use in indicating it might as well be sent to a dime museum.) We hardly know where to look for authorities to put against these, but it may be said that the Patent Office records are above scientific authors in authoritatively determining what is and what is not contained in an invention. Let us see how they help us. It is admitted, then, that Shaw (or Law) was the first, but so far as we can ascertain there is no indication of the "Mann" modification in the English patents. The English patent specifications relating to the "Law" system are respectively dated 30th December, 1879, No. 5,319, and 27th September, 1881, No. 4,165. Both received "provisional protection only." We have these provisional specifications before us at the time of writing. True, a provisional specification does not often tell much, and we are wholly unable to see any indications of the "Mann" modification of the "Law" system in either of the above. We are willing to admit, if our friends desire it, that an American patent may contain the modification known here as the "Mann," but our contention is that before headway in any discussion on telephone systems can be made, we must once and for all determine clearly whether the disputants mean the same thing when one says "Law" and the other says "Mann." The "Law" system as described in the text-books is not in existence in this country, but the "Mann" modification of the "Law" system is in successful use. The "Law" system as we interpret it was tried in this country, and failed; the "Mann" system as we interpret it has been tried, and succeeded. The former may not inaptly be termed a series system, the latter a multiple arc system. This brings us back to the original position. Our contemporary in its issue of February 10, condemned some systems as having been tried and failed. In our issue of February 17 we suggested that if this condemnation was directed at the "Mann system," or the "Mann" modification of the "Law" system, it was hardly correct, as that system had not failed, and we believe that system was the one advocated by the New Telephone Company, or rather by its adviser, Mr. A. R. Bennett. On February 24 our contemporary refers specifically to the "Law system," and that "the Glasgow exchange was in process of transformation to the Law system." In reply, we suggested the possibility of differences arising, because we might be thinking of different things—hence we now attempt to completely determine our position, and would ask the following questions:

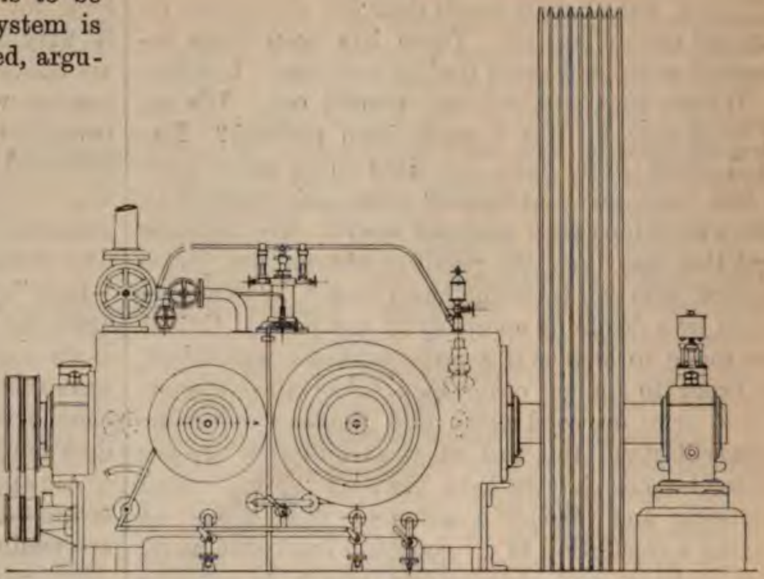
1. Is the Glasgow exchange being fitted with the Law (series) system? or,
2. Is it being fitted with the Mann modification of the Law (multiple arc) system?
3. Is the latter the system that has been tried and failed, or has it been successful at Dundee and elsewhere?
4. Is it not the Mann system, as defined above, that the New Telephone, through its adviser, Mr. A. R. Bennett, advocates?

Our only desire in embarking upon a controversy is to get facts, and get at the truth. We do not wish to deprive the Law Company, nor Mr. Shaw, of any honour that may be due for the invention, but nerely to determine once and for all what is to be ommonly understood when the "Law" system is nentioned. Till this is satisfactorily settled, argument on the question is impossible.

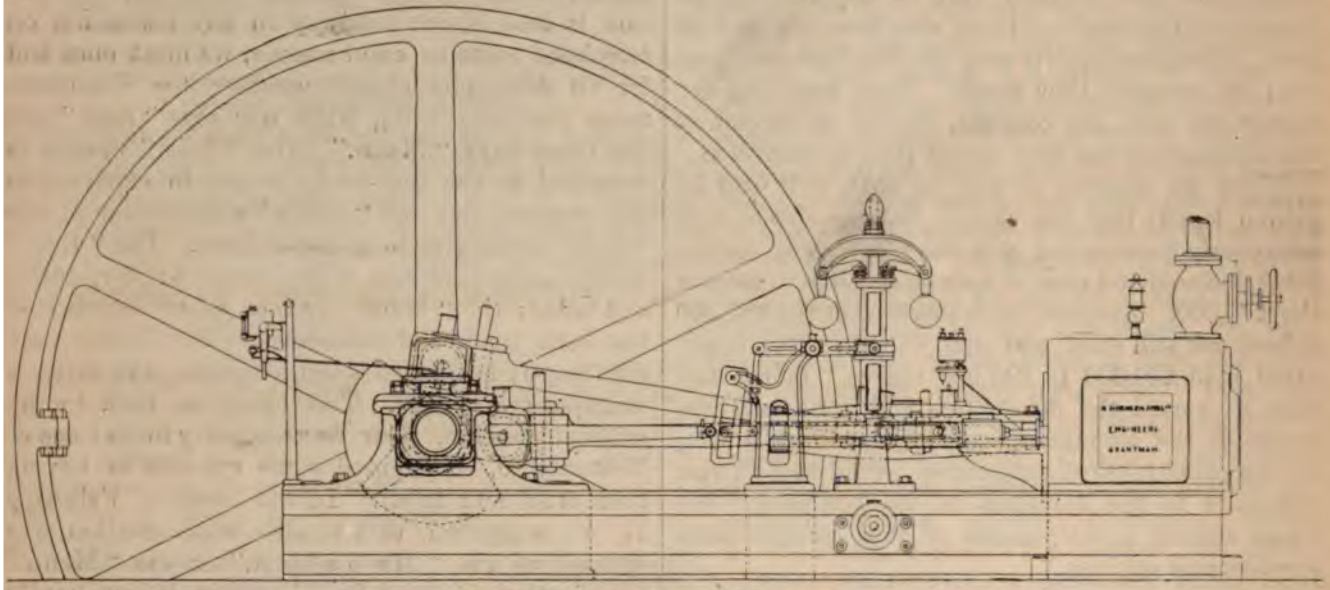
PADDINGTON CENTRAL STATION.

(Continued from page 256.)

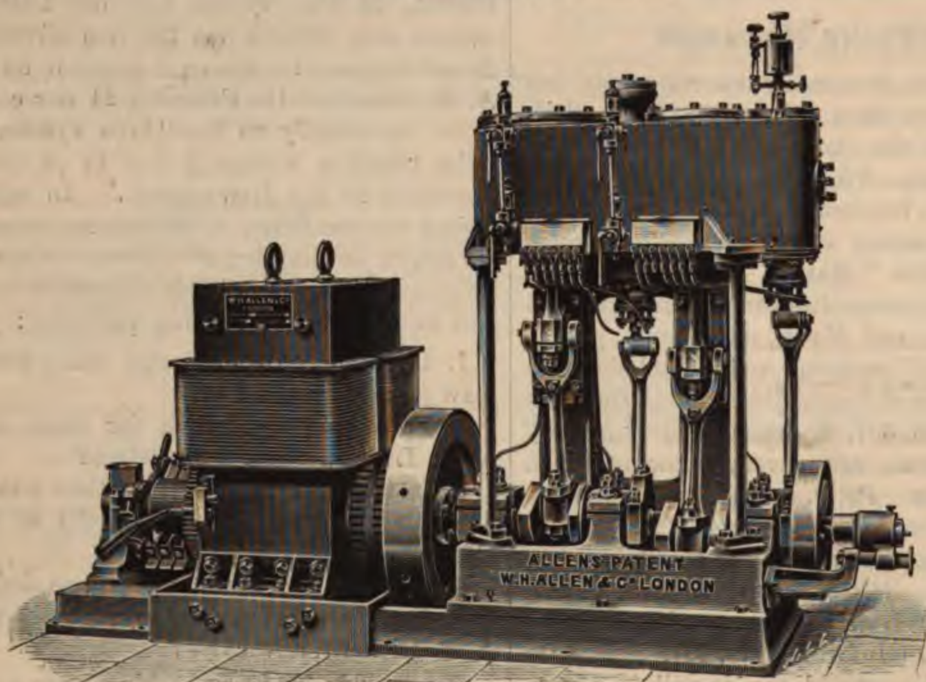
We illustrate this week the Hornsby horiontal compound engines used at the new addington central electric station. There are ive of these engines, and they are all of the ame size and type. The high-pressure cylinder s 15in. in diameter, the low-pressure 24½in. n diameter, and the stroke 27in. The speed s 100 revolutions. These engines easily give 20 i.h.p., about 109 being given off in the igh-pressure cylinder, and 111 in the low-presure cylinder, and this with 140lb. boiler presure. The governors are Hornsby's patent pring type, and control the engine most fficiently, the variation being less than 3 per cent. he engines are fitted with special lubricating arrangements, so that they can run continuously without stopping. Steam is supplied by five large locomotive type



Hornsby Engine—End View.



Hornsby Engine—220 i.h.p.—at Paddington.

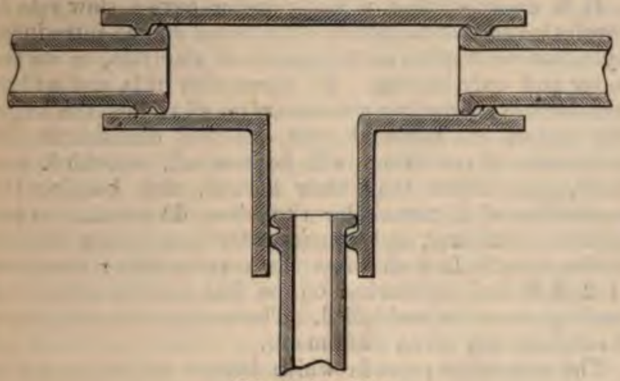


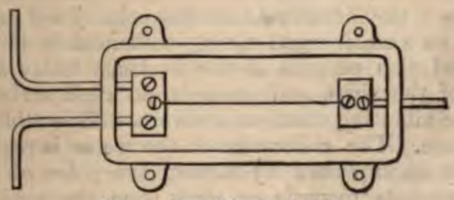
W. H. Allen and Co.'s Combined Engine and Dynamo at Paddington.

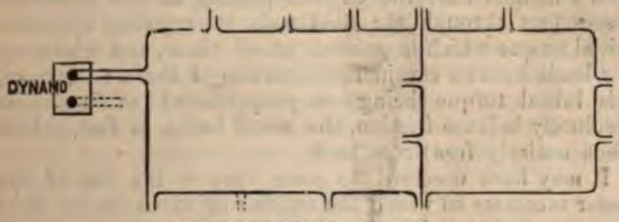
boilers, having about 33ft. of grate surface, and about 1,000ft. of heating surface. Each engine runs with a consumption of 2·22lb. of coal per indicated horse-power, which will, we believe, compare favourably with any other engines running in electric-light stations.

The exciting current for the alternators is taken from a combined set of vertical engine and continuous current dynamo, made by Messrs. W. H. Allen and Co., of Lambeh, shown in another illustration.

The mains are insulated with vulcanised indiarubber for high-tension work, of the well-known Silvertown make. They are laid in pipes in subways. The method of connection to houses is that known as the ring system, long adopted by the Metropolitan Company as very convenient for testing and connection, and though more expensive than the ordinary method for cable, saves in jointing and in ease of connection. Each length is run without joint from one house into the next, two connections being thus run for each pole in each house, and connection is thus made in two directions—either up or down the street. In case of connecting another house, one set is switched off, leaving the other on, and the spare wire withdrawn to make connection to the next house without danger of the current being left on, or the disadvantage of stopping the supply in any house. When the new connection is made by a similar ring the switches are turned on, and all goes on as before. This system has been found very simple and convenient. The total amount of underground mains on the company's whole system now amounts to 250 miles.


Metropolitan Mains.


Metropolitan Primary Fuse Box.



Arrangement, Metropolitan Mains.

The question in which electrical engineers will feel the keenest interest with regard to the Paddington station will be the economy of running. A test has just taken place, extending over 8½ hours at full load, with each of the sets of plant, the load being taken up on a water resistance made by suspending metal plates in the canal outside the works. Readings over the whole period were taken on five instruments—two Elihu Thomson meters, a Siemens wattmeter, and two Siemens dynamometers. The best result showed a fuel consumption of 4·9lb. of coal per kilowatt-hour, and the lowest 5·5lb. per kilowatt-hour. The average, therefore, will be about 5·2lb. per Board of Trade unit manufactured The efficiency of distribution is likely to be high, as the latest types of transformers are being put in, and, as was mentioned the other day, the latest type of Westinghouse transformer gives an efficiency of over 97 per cent. on full load and 90 per cent. on one-tenth load. With similar efficiencies possible on an alternating system using only 5¼lb. per trade unit manufactured, the economy should certainly be high. If the actual results in practice approach this, the Paddington station will stand very favourably as regards plant efficiency.

An interesting fact may be alluded to with reference to the water resistance used in these tests. The two plates are suspended about 30ft. apart, and the loss of pressure in this distance is the whole 1,000 volts. This is a little over 30 volts per foot, and therefore two plates totally unconnected, hung in the water at about a yard apart, would have a difference of potential of 100 volts, and a lamp attached would be lighted. Such a lamp is left floating in the canal, kept alight by means of the potential of the water. Another curious fact is the effect of the electricity upon the fishes; as they come within the sphere of influence they stiffen out under the pressure of five to ten volts due to their own length, and float as if dead down stream. If watched or collected in a basin, they will be seen to recover in a period varying from half an hour upwards, and will eventually swim about as before. A tingling sensation can be quite well felt by dipping the hand or a metal bar into the water at the canal side for some considerable distance around.

(To be continued.)

THE THOMSON RECORDING WATTMETER.*

BY P. J. M'FADDEN.

In this paper on the Thomson recording wattmeter I have endeavoured to give briefly a description of its physical characteristics and the electrical principles underlying its design, and have avoided any discussion of its abstract mathematical equations, as my instructions from your Literary Committee were to prepare a paper that would not take long in its reading, and yet would give those of you who are not familiar with the meter a clear idea of its construction and application in commercial practice.

In designing this meter, several essentials had to be strictly observed: First, the meter must be theoretically correct in principle. Second, it must be of the simplest possible construction. Third, it must be easy to instal and to maintain in operation. Fourth, it must be accurate throughout its range. Fifth. It must be automatic. In addition to these requisites it was the aim of the inventor that the meter operate with equal facility and accuracy on circuits of either direct or alternating currents, and it was his opinion that such a meter should be a motor meter; that is to say, it should be actuated by the same energy which it measures, avoiding, for instance, the necessity, as in clock meters, of winding up the mechanism at stated intervals.

Briefly, then, this meter consists merely of a simple skeleton motor having no iron either in armature or field. The fields, which consist of two coils, one on either side of the armature, are connected in series with the lamps or motor whose absorption of energy they are to measure, all the current in use passing through these field coils. The armature, which is of the Siemens drum type, is hollow and is made of a fibre cylinder over which the coils are wound. On the end of the shaft of the armature is a silver commutator, on which rest flexible bronze brushes provided with silver contact-pieces. The armature is shunted across the circuit in the manner of a lamp, and to cut down its current a high resistance of fine wire is connected in series with it, the whole forming a pressure coil whose current varies with the voltage of the system.

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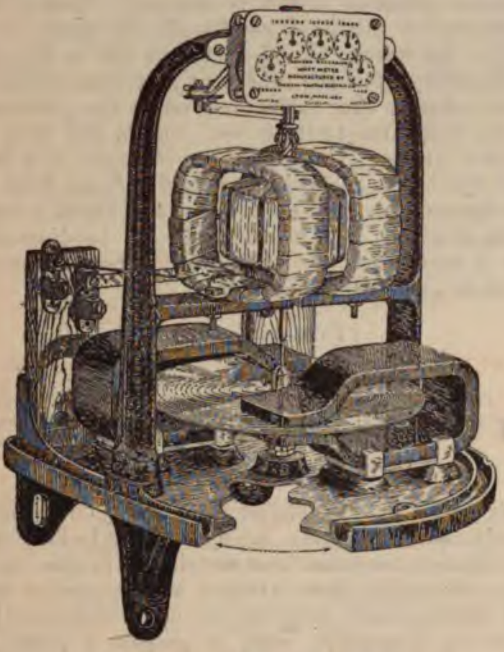
* Paper read before the Chicago Electric Club.

It will readily be seen, therefore, that as the field varies with the current, and the armature with the pressure, the speed of the motor will vary directly with the energy or watts in use, which is of course the ideal method of measurement.

Friction would, however, seriously affect the accuracy of those results were it not compensated for. This is accomplished by taking off the armature circuit beyond the fields. Thus there is a slight constant field, independent of that created by the current flowing to the lamps, caused by the flow of the armature current through the field coils. On very low loads, where friction is a strong factor, this "shunt," or constant field, forms a comparatively considerable percentage of the total field and torque, thus nicely balancing the meter against friction, whilst on medium and high loads both friction and the shunt field become so insignificant a percentage of the total load and torque that their influence cannot be detected and may be neglected.



The Thomson Recording Wattmeter.

Another essential feature of the meter deserves description—namely, the slowing mechanism or means for loading the meter. The necessity for this retarding mechanism is too apparent to need explanation, and has been fully appreciated by all makers of recording motor meters. In the Thomson meter this is accomplished in the most simple and satisfactory manner by placing on the shaft a thin disc of copper, some little distance below the armature. This disc rotates between the poles of three permanent magnets, as shown here.

The fields of these magnets generate Foucault or eddy currents in the disc, thus forming a considerable drag or load on the motor, which is constant and proportionate in its action. Thus it will be seen that, neglecting friction, which, as we have noted, is compensated for, the meter is proportionate throughout, for torque is directly proportionate to the product of current in armature and fields, which equals amperes × volts—that is, torque is directly proportionate to power or watts passing the meter. Speed is directly proportionate to torque, and the retarding effect or generation of current in disc is directly proportionate to speed: therefore the theory of the instrument is consistent and correct throughout.

Another good feature of the meter exists in that the drag or load is considerable; hence friction, which is the only varying quantity, forms, even on light loads, but a small proportion of total retarding effect.

The indications of the meter are shown in watt-hours on the dial, the first wheel of whose train engages with a worm on the shaft, thus connecting it with the revolutions of the armature. The five dials of the whole train will record up to 10,000,000 watt-hours—that is to say, approximately 200,000 lamp hours—and it is only then that the dials all come back to zero. This for the smaller sized meters without constants. The largest sizes will register as high as 360,000,000 watt-hours before reaching zero again.

By an examination of this dial it will at once be apparent that the friction absorbed in actuating the recording mechanism is so small as to be negligible, as the power required is so slight that it is scarcely possible to move with the finger the first gear, which engages with the worm on the shaft so slowly as not to see the first dial hand move, and yet when the meter is running at full load this motion of the dial hand is not discernible. Here, then, is one of the two possible chances for friction reduced practically to zero.

It is essential that a motor meter have a slow rate of revolution so that no possible resistance can be introduced by reason of friction of the gears of the train, or on the lower and only bearing. To accomplish this, and still to use the same recording mechanism on all meters, the larger size meters are made of such electrical dimensions that their rate of revolution will be one-half, one-third, one-sixth, etc., slower than their normal, thus keeping the revolutions of all meters down to about 60 revolutions per minute at full load, and consequently lengthening the life of the meter. In such cases the corresponding constants of 2, 3, 6, etc., are marked on the dial, and by which the readings are to be multiplied. These constants are uniform throughout any given sized meter.

The only other point in which friction might appear is at the bearing on which the lower end of the vertical armature shaft rests. This again is reduced practically to zero by having the shaft's point hardened, very carefully ground and highly polished, and in having the bearing made of sapphire. This jewel is inserted in the end of a brass screw, which passes through the bed-plate of the meter.

If the jewel should, by reason of a continual vibrating or pounding of the shaft upon it, become cracked, the point of the shaft would become worn and the meter run slow. To prevent the occurrence of this, the jewel setting is mounted on a small spiral spring contained in the hollow screw, and this permits of the bearings following every motion of the shaft and presents no rigid surface upon which the vibrating shaft can deliver a sufficient blow to do any damage. The calibration of the meter is readily and effectively accomplished by moving the poles of the permanent magnets towards or away from the periphery or centre of the disc, thus increasing or decreasing its speed until it become synchronous with the standard instrument.

We have seen by the description just given that the theory of the Thomson recording wattmeter is necessarily mathematically correct, save from that slight error which is induced by friction on the lower loads. We have also seen that this error is reduced to an almost negligible quantity by connecting the armature into the circuit in such a manner that the current passing to the armature passes first through the field coils, thus giving a certain initial torque which is present at all times, and which on low loads forms a considerable portion of the total torque, this initial torque being so proportioned as to almost absolutely balance friction, the meter being, in fact, poised when entirely free from load.

It may have occurred to some that as the size of the meter increases so would the number of turns in the field decrease, and therefore a meter of 100-lights capacity would not have the same amount of initial field due to the armature current passing through the series coils as would a meter of small capacity. Strictly speaking, and were no provision made for it, this would be quite true, but in cases of this kind the initial torque is maintained by the insertion of what is termed the shunt-field coil, wound inside of one or even in some cases of both the series field coils. In cases of this kind the current passing through the shunt field, acting in unison with and in the same direction as the series fields, and then through the armature, maintaining approximately the same number of initial armature field turns and the same initial torque to counterbalance friction.

It is this nicety of construction which enables the Thomson recording wattmeter, even in sizes as large as 100 amperes, actually to give a registration on loads as small as one lamp.

No difficulty is experienced in adapting the Thomson recording wattmeter to all purposes. Its theory and its construction is good alike for use in all connections. Thus, there being no iron whatever in the frame, in the armature, in the field or cover of the meter, its accuracy remains unchanged with the same calibration, whether it be installed on alternating or direct current, and this being true it is, of course, obvious that no variation in frequency can in any way affect the accuracy of the meter.

It may be well here to say a few words as to the watt-hour as a unit of measurement. In the watt-hour we have what may be very honestly termed a universal unit. No matter what variation of voltage the meter may be subjected to, no matter whether operating upon power or upon light, whether being used to measure the output from a station or to measure the total input of electrical energy into a house having but three lamps, the watt-hour means the same thing.

It has been customary with many manufacturers to adopt the ampere-hour as the unit of measurement, but the ampere-hour, while a very good thing for ampere-meters, is in reality no measurement whatever of the energy used except at one fixed potential. It is a recognised fact that a recording ampere-meter, except at the potential for which it is calibrated, does not accurately record the power passing through it; and so an ampere as a unit designates only half of the question. It indicates how much current has been used, but to obtain results as to the amount of power used it is necessary to assume or determine the voltage and multiply the result.

By a fortunate coincidence the basis of charge dependent upon 1,000 watt-hours found a parallel in the familiar basis of charge for gas. That is to say, experiment has shown that 1,000 cubic feet of gas will give about ten times the illumination of an incandescent lamp consuming 1,000 watt-hours, and if a customer has been paying 2.00dol. for 1,000 cubic feet of gas, he would, if he were to be charged at the same rate for his illumination, pay 20 cents per 1,000 watt-hours for his consumption of electricity.

The Thomson recording wattmeter is made for lighting or power circuits of all commercial voltages, and for primary circuits of alternating-current stations for measuring the total output from an alternating machine, and for measuring the output of direct current of light or power stations in sizes from 10-ampere to an instrument as high as 600-ampere capacity, one meter thus being capable of measuring the output of some of the largest generators now made.

These meters are also made to record on a single dial the summation of energy from both sides of an Edison three-wire system, and to measure the power consumed by an electric car, to check the wastefulness or economy of the motorman; in fact they are made in about 55 different forms, varying in voltage, amperage, and in construction according to the uses for which they are intended.

I trust that these brief notes have sufficed to convey to you an idea of the main features of this meter, and perhaps to have suggested to your minds some other points which, in the limited space afforded me, I have not been able to touch upon, in which case I will be pleased to answer any question I may be able to touching the subject.

ROYAL METEOROLOGICAL SOCIETY.

At the monthly meeting of this society, held on Wednesday evening at the Institution of Civil Engineers, Dr. C. Theodore Williams, president, in the chair, Mr. Shelford Bidwell, F.R.S., delivered a lecture on "Some Meteorological Problems," which was illustrated with numerous photographs and experiments. The lecturer said that one of the oldest and still unsolved problems of meteorology relates to the origin of atmospheric electricity. Many possible sources have been suggested, among them being the evaporation of water and the friction of dust-laden air against the earth's surface. Experiments were shown demonstrating that evaporation on hot sand and friction of falling sand both caused electrification. Having granted some sufficient source of electrification, Mr. Bidwell said that it is not difficult to account for the ordinary phenomena of thunderstorms. Photography has shown that the lightning flash of the artists, formed of a number of perfectly straight lines arranged in a zig-zag, has no resemblance to anything in nature. The normal or typical flash is like the ordinary spark discharge of an electrical machine; it follows a sinuous course, strikingly similar to that of a river as shown upon a map. The several variations from the normal type all have their counterparts in the forms taken by the machine spark under different conditions, and the known properties of these artificial discharges may be assumed to afford some indication as to the nature of the corresponding natural flashes. Thus, for example, the ramified, or branched flash, from which no doubt the dreaded "forked lightning" derives its name, is probably one of the most harmless forms of discharge. Ever since the time of Franklin it has been customary to employ lightning-rods for the protection of important buildings. According to Dr. Oliver Lodge, these are of no use in the case of an "impulsive-rush" discharge, which, however, is of comparatively rare occurrence. Lightning-conductors, however well constructed, cannot therefore be depended upon to afford perfect immunity from risk. Mr. Preece, who claims to be personally acquainted with half a million lightning-conductors, is of opinion that the impulsive rush, though easily producible in the laboratory, never occurs in nature; but it seems quite certain, said Mr. Bidwell, that it may occur. Although in the great majority of cases lightning-rods will protect buildings, yet the assumption made by the older electricians, that damage to buildings necessarily proves defect in the lightning-rod, is an unfounded one. Mr. Bidwell made some remarks as to the duration of a lightning flash and the causes of its proverbial quiver as probably due to flashes twice or thrice repeated on the same path. Ribbon flashes he thought due to moving of the camera, and the so-called "dark flashes" had been proved to be due to leaving the camera open a little longer, and was not an electrical effect at all. He suggested an explanation of the characteristic darkness of thunder-clouds, and demonstrated an artificial effect by electrifying a cloud of steam. The large raindrops which fall during a thunder shower were due to coalescing of drops when electrified. The lecturer concluded with some observations and experiments concerning the probable cause of sunset colours, which he attributed to the presence, in greater or less number, of minute particles of dust in the air.

COMPANIES' MEETINGS.

SCARBOROUGH ELECTRIC SUPPLY COMPANY.

On Friday last, the first statutory meeting of the shareholders of the Scarborough Electric Supply Company, Limited, was held at the Company's offices, 102, Westborough. Lieut.-Colonel R. F. Steble, chairman of the Board of Directors, presided.

The **Chairman** said that the meeting was a formal one, being the statutory meeting they were obliged to hold within four months from the date of the registration of the Company, and he did not intend to do more than explain what had been already done in connection with the formation of the Company, and the construction of the works. In the first instance, the Corporation had the power to bring electric light into the town, but they came to the conclusion that it would be wiser to let a private company introduce it and supply it for a term of years, as they (the Corporation) would have the power to purchase at the expiration of that time. A concession was thereupon granted to Mr. Campbell Swinton, and he set about at once to form a company to carry out the order he had obtained from the Board of Trade. He experienced no difficulty in doing so. He asked several Scarborough men in particular to become directors, and he induced him (the Chairman) to take a place on the Board. The Chairman said at first that he was afraid he would not be able to give the necessary time to the duties, but he eventually consented to serve because he had always felt that if he could do anything to benefit the town or its inhabitants he was only too glad to do it. He had also had the electric light installed in his own house for seven years, and therefore it was not a question of electric lighting for himself, but for other people. The Company was formed with a nominal capital of £50,000; and the Directors then ascertained what the cost of starting the works would be. It was estimated that they would entail an expenditure of £20,000, and they then determined to make an issue of shares up to £20,000. They had not the slightest difficulty in realising that sum of money; and he was now going to make a suggestion, with which he believed the other Directors would agree, that they should increase the capital still further, not for the purpose of calling it up all at once, but in order to relieve those who had already subscribed and to enable them to extend the works without going cap in hand for the money and paying an enormous price for it. The Chairman then went on to narrate the troubles the Company had in fixing upon a generating station. They first looked to the east end of the town. The suggested site there was too confined for future extensions, and although they would have got permission to obtain a passage through to the sea for condensing purposes, their engineer thought that the risks of injury to the sea-wall and to the works through silting were too great. They therefore decided that the site would not do. They then looked over a site in the centre of the town, which he candidly told them he would have had if he could, but after going into the matter thoroughly they found the site would not furnish the space required for storing the water for condensing purposes. Condensation saved coal, and they could not get on that site space to supply the 250,000 gallons per hour which would be utilised—flowing and returning—when the works got into full operation. Then Mr. Peacock offered a site in Seamer-lane, and the Chairman stated the conditions under which it had been secured, and the progress of the works. They could on that site extend their works to provide 100,000 lights if necessary, and he loo with great hope on the prospects of the Company. He was not one who talked about making fortunes in five minutes, but they had good prospects of success. Several shops and private houses were already wired, and if they were only to get a portion of the estimates already made they would start very well. Many people made remarks and wrote things about the cost of the electric light without duly considering what they said. He was not going to tell them the electric light was as cheap as gas, but if the Company were well supported they could afford to reduce their price down to a minimum and still leave a fair dividend to the shareholders He did not for one moment, as Chairman of that Company, wish to set up the Company in opposition to the gas company, but he was simply supporting what he believed to be the best illuminant. He believed gas companies had a great future as providers of motive power, but they could not compete with the electric light as an illuminant. He then described what he considered to be the advantages of the electric light from a health point of view, and also dwelt on the economy which customers should exercise in consuming it by putting on switches which would enable them to control every single light they used. In conclusion, the Chairman said that it had been often remarked to him, "I cannot understand why Scarborough is so far behind the times. You seem to think you can stand simply upon your natural attractions." It was pointed out that Brighton, Blackpool, Eastbourne, Morecambe, and other season places had the electric light; but that the Scarborough Spa—which was practically closed eight months in the year—though one of the grandest places in the kingdom, if illuminated by electricity, was deficient of that light. If they wanted Scarborough to advance, people said, it must keep pace with the times and not expect to get their season extended from any small ideas. If Scarborough did not do so, it made a great mistake, and he mistook the people of the town if they did not take advantage of all modern improvements. Their dealings with the Corporation so far had been amicable, and they had not had the slightest impediment placed in their way. The Company would do their best to serve not only the Corporation, but the town generally, and, on the other hand, he hoped the townspeople would come to the support of the Company, for the light would be a very great improvement.

Councillor John Hall then read the following

Report of the Architects.—The architects have to report that the several works in connection with the erection of the generating station in Seamer-road are being satisfactorily proceeded with by the contractor, Mr. William Peacock, sen. The excavations for the formation of chimneys are completed, the concrete bottom has been filled in, and the brickwork commenced. This also applies to the work in connection with the wells to the engine-house, the footings to the engine and boiler house are being rapidly pushed forward, so as to set on the bricklayers by Monday next. The excavations for the pond, which cover an acre of ground, are well in hand, a large number of men and horses and carts being engaged thereon. Mr. Saul (the clerk of the works) is in constant attendance on the works, and exercises every care in order that the work may be thoroughly well done, and we have every reason to hope that the whole of the works will be completed by the time agreed upon.

The Engineer's Report.—The managing director and consulting engineer (Mr. A. A. Swinton) presented a report, from which we extract the following: In the present early stage of the Company's existence, there is not very much to say, except to describe generally the plant that is being supplied for generating and distributing electricity. The generating plant that has been ordered, and which will probably be sufficient for some little time to come, will consist of two independent sets of engine-dynamo, each set being of about 200 h.p. and capable of supplying 150 electrical units. The engines are of the Parsons steam-turbine type, and drive the dynamos direct at a speed of about 5,000 revolutions per minute, or about 80 per second. After referring to the towns where such machinery had been in use, the engineer went on to say that steam would be supplied to the engines at 120lb. steam pressure by two Lancashire boilers, each 28ft long by 7ft. 6in in diameter. The supply station will be furnished with the usual complement of subsidiary machinery, consisting of two feed-pumps, traveling overhead crane, switching apparatus, measuring and regulating apparatus, etc., all of a very complete description. The capacity of the machinery now arranged for and ordered is 300 units, or about 400 h.p., sufficient to supply about 7,000 lamps; the buildings are, however, being built, and the pond excavated with a view to ultimate requirements. The engine-house will take five additional sets of engine-dynamos and condensers, and the boiler-house is being so built that as future boilers are required they can be added. The ultimate capacity of the buildings being about 50,000 lamps, a number that is not likely to be reached in Scarborough for many years to come. After referring to the sanction of the Corporation having been obtained to a pressure of 2,000 volts, the engineer goes on to state that it may be well to point out that this high pressure is not really a matter that concerns the public at all. Whatever the pressure—high or low—that is sent out from the generating station, such pressure is invariably reduced to a perfectly harmless 100 volts before it reached the consumers' wires and lamps. It is right to point this out, as those interested in decrying electric lighting raise the question of its safety. Accidents will sometimes happen. Gas does explode on occasion, and accidents have been known with electricity. The fact, however, may be maintained, without fear of contradiction, that while with gas it is usually the public that suffer, with electricity it has invariably been the supply companies' own employés that had been hurt. Since the introduction of electricity some 10 years ago, there have been only six fatal cases in Great Britain altogether, but one had only to read the daily papers to see how very different it is with gas. Referring to the mains, he said it is proposed to lay down about 4½ miles of these in the first instance. This length will cover the chief business and residential quarters of the town, and thereafter extensions can be made as the demand arises. The mains will consist of highly-insulated cables drawn into cast-iron pipes, and laid under the footways, with junction-boxes about every 50 yards. Referring to Newcastle-on-Tyne and Cambridge, where similar machinery, etc., are used as proposed at Scarborough, he pointed out that at the latter place the company was making a good profit, and the former paid last year a 5 per cent. dividend, and this year 5½ per cent. This is doubly encouraging, since he said gas in Newcastle is much cheaper than in Scarborough. This brings us to the question of the price which it is proposed to charge for electricity. The Company have power to charge 7d. per unit, which is equivalent to a farthing per hour for an 8-c.p. lamp. For large consumers, however, it is proposed to make a considerable rebate, amounting to 25 per cent., to those who have a large number of lamps and burn them for long hours.

Mr. J. W. Woodall said so far as he had been able to see the shares of the Company had been remarkably well taken up, and he trusted that in a short time the whole system would be extended, and become more popular in the town.

The retiring directors, the ex-Mayor (Lieut-Colonel Steble), Mr. J. W. Woodall, J.P., and the Mayor (Mr. John Dale), were re-elected.

On the motion of the **Mayor**, seconded by **Mr. D. Edwards**, Mr. C. E. Bradley was appointed auditor at a remuneration of 15 guineas per annum.

Mr. F. Bright asked if there was any period specified when the works might be completed.

The **Chairman** replied that he could not give a guarantee, but they expected early in July.

A vote of thanks having been passed to the Chairman on the motion of **Mr. Edwards**, seconded by **Mr. F. Bright**, the meeting terminated.

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The third annual meeting of the Birmingham Electric Supply Company, Limited, was held on Thursday last week at the offices in Dale End.

The **Chairman**, in moving the adoption of the annual report, said that the Company's experience for 1890 might be summed up as slow but steady and satisfactory progress. The number of lamps being supplied at the close of 1891 was 5,480, and at the close of 1892 the number was 8,329, the average for the whole of last year having been 6,830, as compared with 3,135 for the nine months preceding. The number of consumers increased during last year from 133 to 223, and was still increasing. It was satisfactory to note the increasing demand for the arc light, showing that consumers were fully alive to the fact that no light was more economical, not even the city gas. The Company's cost of production compared favourably with that of any other company in England, but it was a matter of regret that in contracts for fittings the margin of profit was so small. Last year the profit under that head amounted to £260. In the majority of cases the Company could not attempt to do work at the prices at which other contractors under the pressure of competition were prepared to do it. Since the last annual meeting they had issued the whole of the remaining share capital, and the Company was now in the satisfactory position of having its entire share capital placed, and being entirely unfettered by preference shares or debentures—a state of affairs that was rather unusual with electric supply companies in the United Kingdom. The Directors proposed to add to the depreciation reserve fund £1,279, bringing that fund to £1,636. This was considered ample for the time the Company had been in existence. Before recommending the payment of a dividend, the Directors thought it wise, in view of the existence on the other side of the balance-sheet of the item of £1,685 preliminary expenses, that something should be done towards creating a general reserve fund. They therefore proposed to carry £250 of the year's profits to that fund, and to declare a dividend of 3½ per cent. This dividend, he thought, would be considered satisfactory by the shareholders considering the time the Company had been at work. It was rather astonishing to him that some of their large banks and other establishments had not yet adopted the light, to the advantages of which the proprietors seemed to be fully alive. The chairman of one of the largest banks in Birmingham remarked that he did not hesitate to say that the entire cost of the change would be saved to the bank in the improved health of the staff. In reference to the proposed extension to Edgbaston and the jewellers' quarter the Company had been treated, as it always had been, with the greatest courtesy by the Corporation, but in view of the attitude of the committee to which the matter was referred, they had abandoned the intention to apply for increased powers this session. The Company, however, would bring the matter forward again as soon as possible, and would press its claim upon the Corporation, unless the Corporation decided to supply those districts itself.

Mr. C. A. Harrison, in seconding the motion, said that the shareholders had reason to be most grateful for the results which had been achieved.

The motion was carried unanimously, and the retiring directors (Messrs. G. S. Albright and Mitchell) and the auditors (Messrs. Sharp, Parsons, and Co.) were re-elected.

NEW COMPANIES REGISTERED.

Oswestry Electric Lighting and Power Company, Limited.—Registered by Jordan and Sons, 120, Chancery-lane, W.C., with a capital of £10,000 in £1 shares. Object: to carry on the business of a company for the supply at Oswestry, or elsewhere, of electricity in all its branches, and, in particular, to supply by electricity, light, heat, and power to any person, firm, company, or corporation, municipal or local authority, and to create, accumulate, and distribute electricity, magnetism, or any other similar agency. The subscribers are: W. W. Coulson, Oswestry, chartered accountant; E M. Gardner, Oswestry, ironmonger; R. E. Hughes, Oswestry, draper; F. F. Leader, Oswestry, bank manager: A. Marshall, Oswestry, printer, etc.; J. Marshall, Oswestry, ironmonger; R. Taylor, Oswestry, stationmaster.

Ebenezer Timmins and Sons, Limited.—Registered with a capital of £20,000, in £20 shares, to acquire and take over as a going concern the businesses of engineers, ironfounders, contractors, heretofore carried on at Runcorn, Chester, and elsewhere, under the style of Ebenezer Timmins, and to carry on the business of civil, mechanical, electrical, marine, artesian well, and general engineers, ironmasters, brassfounders, metal workers, metallurgists, shipowners, and all auxiliary trades.

BUSINESS NOTES.

Interlaken is to have a central station.

Dresden.—The alternating-current system is to be used at Dresden.

Electric Loom.—The Thomson Welding Company have purchased the patents of the Lombard electric loom.

Huddersfield.—Tenders for wiring the Market Hall at Huddersfield are invited by the Corporation by 1st April.

Colombo.—The question of constructing tramways, electric or other, at Colombo, is being discussed by the Town Council.

Train - Lighting.—It is intended to light up the railway carriages of the Berlin Town and Circular Railway by electricity.

Indian-Ink Stand.—The adjustable stand we mentioned for draughtsmen's Indian ink is made by Reeves and Sons, of Cheapside.

Preston.—The shopkeepers of Church-street and Friargate, at Preston, are clamouring for the extension of the electric light to their district.

Axbridge.—The Axbridge (Somerset) Local Board have agreed to meet a representative of the Brush Company and hear what is to be said in favour of the electric light.

Zurich.—The Zurich central station is being increased by a 150-h.p. Kapp alternator, and the Oerlikon Company are building two other 300-h.p. alternators for Zurich.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,484.

Russia.—The French Continental Compagnie Edison has received authority to exploit electricity in all its branches in St. Petersburg, Moscow, Odessa, Kiev, Tula, Warsaw, and Twer.

Chesterfield.—The Electric Lighting Committee of the Chesterfield Corporation have decided to call in an expert to advise them as to the best method of introducing electric lighting into the town.

Australia.—Mr. A. F. Williamson, late of the Williamson Electrical and Engineering Company, of Sydney, has commenced practice at 255, George-street, Melbourne, as consulting electrical engineer.

Traffic on the Liverpool Overhead Railway.—The number of passengers who travelled by the Liverpool Overhead Railway during the week ending 12th inst. was 104,140, and the receipts were £1,003.

Redditch.—At the Redditch Local Board Mr. T. Evans postponed till a later meeting the resolution of which he had given notice, that the Board should apply for a provisional order for lighting the town with electricity.

Montrose.—Notice has been given to the Montrose Municipal Corporation by Mr. Strachan that he will move for appointment of a committee to consider the propriety of having the town lighted by electricity, to be generated by the use of the river.

Switzerland.—One of the most beautiful little valleys of Saxon Switzerland, we learn, has been used as a water-power centre for electric lighting, to supply Schandau, Königstein, Stolpen, Wahlen, Dohna, and quite a number of other small towns within a radius of 10 miles.

Swansea.—At the meeting of the Swansea Public Library Committee last week, application was recommended to be made to the electric light company for an estimate of the cost of lighting the Central Library with electric light. The report was adopted without discussion.

Southend Pier.—At the Southend Town Council meeting on the 8th inst., it was resolved to raise a loan of £4,000 for providing further electrical plant and cars for the pier. The tender of Messrs. Crompton and Co., of Chelmsford, for additional plant in connection with the pier tramway, amounting to £1,988, was accepted.

City and South London Railway Company.—The receipts for the week ending March 12 were £859 against £876 for the corresponding period of last year, or a decrease of £17. The total receipts for 1893 show an increase of £1,023 over those for the corresponding period of 1892.

Portable Transformers.—The Sir David Salomons portable high-tension transformers will be put on sale by the General Electric Company at about two guineas. These interesting transformers are being made by Messrs. Pyke and Harris, the sale being in the hands of the General Electric Company.

Personal.—Mr. A. B. Gill has lately joined the firm of Messrs. J. Stone and Co., engineers, Deptford, as manager of the electrical department. Messrs. Stone are a large firm giving employment to several hundred men, the works occupying a large plot of ground near New Cross Junction. The works are being extended to take in electrical engineering.

Chiswick.—At the Local Board meeting last week, the clerk reported concerning the lighting of Chiswick with electricity, and the communications with Messrs. Bourne and Grant and the Board of Trade, that he was about to wait upon the Board of Trade in reference to the matter, and hoped that Mr. Compton, the chairman of the Board, would accompany him.

Barnet.—The Board of Trade, after careful consideration of the objections of the Barnet and District Ratepayers' Association, propose to grant the electric light provisional order. They point out that it will be necessary for the Barnet Local Board to obtain the consent of the Local Government Board before they can borrow money to give effect to the provisions of the order.

Wigan.—By reason of the petition of the National Telephone Company, the Parliamentary Committee of the Wigan Town Council have decided to abandon the application for power to work by electricity "other than by electric power carried with the carriages on tramways," which would dispense with the objections raised in the petition of the telephone company.

Craig-y-Nos.—We understand that the extension of electrical work at Madame Patti-Nicolini's is more extensive than our note of last week suggested, and therefore the amount being spent is also far larger than was mentioned. Messrs. Bergtheil and Young are the electrical engineers doing the work, and we hope in a short time to be able to give full particulars of the whole extension.

Aberdeen Harbour Quays.—Aberdeen Harbour Commissioners have rejected, by 13 to 10 votes, a proposal by Treasurer Bisset to ask the Docks Pilotage Committee to report as to the propriety of having the harbour quays lighted with electricity. Mr. Bisset stated that the expense of lighting the harbour with gas last year was £383 5s. 2d., whereas electricity would cost £1,320 per annum.

Stockton.—At the monthly meeting of the Stockton Town Council, attention was called to the condition of the tram lines, but it was stated that it was expected a new company would before long be formed who would use electricity as the motive power. The present company had recently realised a portion of their Darlington property for £800, and were going to spend it in improving the Stockton line.

Harrogate.—At the monthly meeting of the Harrogate Town Council held on Monday the Town Clerk reported as to the extension of time for the carrying out of the electric lighting order, and he also presented a report from the town clerk of Scarborough as to the steps which had been taken there for the transference of the powers of the Corporation to a company, and it was resolved that the Special Committee should prepare a further report.

Llangollen.—At the Llangollen Local Board last week, Mr. Davies said that, in regard to the question of lighting the town by electricity, two or three engineers had expressed themselves very much in favour of the scheme. He had received the report of one of them, but had not got the one he thought would be the best. Under the circumstances he would ask the permission of the Board to defer the matter for a month. Leave was granted.

Placard.—We have received a wall placard from Messrs. Andrews and Preece, Borough Mill, Bradford, setting forth the value of Preece dynamos when driven by gas-engines and Dowson gas. A "sweetly pretty" young lady gazes with an ecstatic air at a pendant electric light, supplied from one of the aforesaid dynamos. We notice that this illustration, like so many other electrical illustrations, has been done by that clever draughtsman, Mr. A. Snell.

Dewsbury.—The Lighting Committee of the Dewsbury Town Council at the last meeting submitted minutes stating that alternative plans, prepared by Mr. W. H. Preece, for the laying out of the old gasworks' site as a central station for electric lighting were submitted. It was decided that Mr. W. H. Preece be engaged as consulting and superintending engineer. The committee are to inspect the Liverpool electric station on the 17th inst. The motion was carried.

Embankment Lighting.—On the recommendation of the Highways Committee, the London County Council approved of the appropriation of a piece of land adjoining the Charing Cross District Railway Station for the purposes of a generating station in connection with the electric lighting installation, for which the Council was seeking powers in its General Powers Bill of this session, for the Victoria-embankment and ornamental gardens, and the Westminster and Waterloo Bridges.

Houses of Parliament.—The First Commissioner of Works intends to ask for a vote of £12,000 to extend the electric lighting arrangements in both Houses of Parliament. Only £1,600 will, however, be expended in the coming year. The cost of electric lighting last year in the House of Commons was £1,800. The gas in both Houses and in the offices and halls thereto pertaining cost £2,775. Oil lamps, almost entirely superseded by the electric light, mysteriously cost over £1,300 a session.

Edinburgh.—Prof. Kennedy has forwarded his report to the Lord Provost's Committee of Edinburgh Town Council on the question of the electric lighting of the city. The report will be considered at a meeting of the Lord Provost's Committee this week. The estimate for a central installation for the scheduled area is £85,000. In the report the questions of low and high tension are discussed, and certain recommendations are made which, it is understood, include the adoption of both systems under certain conditions.

Bolton.—A sub-committee of the Corporation had under consideration on Friday last the applications received from candidates for the post of resident electrical engineer. Altogether there were 62 applicants, and of these eight were selected to appear before the committee at their next meeting. They are as follows: Thomas Barnard, of Wigan; H. C. Crews, Manchester; W. A. Heyes, Bolton; Thomas Oddy, Rochdale; J. B. Mitchell, Bradford; Joseph Shephard, Leeds; J. H. Ryder, Halifax; and C. H. Yeaman, Liverpool.

Dundee.—The engine and dynamo room of the Dundee central station is large and airy, and is admirably lighted by a series of roof-lights. The room is 65ft. long and 25½ft. wide, and it is decorated with enamelled brick, with a dado of coloured brick. There are six engines, four of 135 i.h.p. each, and the remaining two of 60 i.h.p. The dynamos are coupled direct to the engine shafts on the same bed-plate. An air condenser has been placed on the roof of the boiler-house, and this is a feature of the works which is particularly interesting.

Brighton.—An enquiry was held at the Town Hall last week by Mr. Ingram B. Walker and Major Cardew, R.E., inspectors appointed by the Board of Trade, with reference to the application of the Brighton Electric Lighting Company for a provisional order to supply electricity for public and private purposes. Mr. Castle, Q.C., represented the electric lighting company; Mr. Hugh J. Verrall appeared on behalf of a committee of the customers of the company; and Mr. Fletcher Moulton, Q.C., and Mr. C. G. Boxall were counsel for the Brighton Corporation, who opposed the application.

City Lighting.—A transformer sub-station for the City of London Electric Company is being built in the middle of Salisbury-square, near our offices. We hope our types may be set by electric light before long, and even, who knows, the presses driven by electric motors. Unfortunately, for the latter purpose, alternating-current motors are not yet commercially available in the same manner that are direct-current motors. There would be an enormous demand for electric motors both in the day and in the small and early hours if they could be got within the reach of the printing-presses.

Sheffield Telephone Subscribers—A meeting of the committee appointed to watch the interests of the subscribers to the National Telephone Company in the Sheffield district took place last week, Mr. R. Belfitt, ex-master cutler, occupying the chair. Some time ago a form of agreement, prepared by the committee, was submitted to the telephone company. The company suggested certain modifications, and the agreement was adopted in its altered form. A copy of the agreement, with a circular, will be sent to all subscribers. The committee recommend subscribers to sign the altered form of agreement, but not for a longer period than 12 months.

Chester.—The Chester Town Council have decided that the arrangements for lighting the city should be continued until 1894. Mr. Browne asked, incidentally, how the electric lighting system was going on. The Town Clerk replied that the committee had called in one doctor, but before taking his advice they thought they would have a second opinion. Mr. Browne: In the meantime the patient may die. The Mayor did not think they would suffer by the delay, as the light was being perfected. This, we beg to assure his Worship, is an excuse for delay that cannot be substantiated. As perfect a light as Chester wants can be obtained, and at once.

Edinburgh and Leith.—At the annual dinner of the Edinburgh and Leith Gas Commission, Mr. Turnbull Smith proposed "The Corporation of Edinburgh," which was responded to by the Lord Provost, who spoke of the prospective introduction of the electric light into Edinburgh, and referred to the report which they had received that day from the consulting electrical engineer. The Lord Provost said he believed that while undoubtedly the electric light would be a keen competitor of the gas, the gas corporation would in no wise suffer, as the gas would, as in other places where the electric light had been introduced, be largely used for other purposes than as an illuminant.

Electric Tramways in Vienna.—The Anglo-Austrian Bank, says *Industries*, are negotiating for the formation of a company to construct and operate electric tramways in this city. The tramways will be similar to those in operation in Budapest. The Town Council of Carlsbad are going seriously into the question of constructing an electric tramway. A scheme drawn up by Messrs. Ganz and Co., which provides for a culvert tramway on the Zipernowski system, is under consideration. Two schemes are being considered for the electrical tramway at Lemberg. One has been submitted by the Oerlikon Company and the other by the Union Company (the Thomson-Houston system).

Direct Spanish Telegraph Company, Limited.—The report for the half-year ended December 31 shows, after providing for debenture interest, a balance to the credit of profit and loss of £5,439. After adding £2,500 to the reserve fund, the balance amounts to £2,939. The directors recommend dividends at the rate of 10 per cent. per annum on the preference shares, and at the rate of 4 per cent. per annum, tax free, on the ordinary shares, leaving a balance of £442, which will be transferred to the reserve fund in part repayment of the balance of £1,935 still remaining due to that fund for the repairs of the Falmouth-Bilbao cable in November, 1891. The reserve fund now amounts to £33,273.

Braintree.—At the meeting of the Braintree Local Board on the 3rd inst., a letter was received from the Boiler Insurance Company offering terms for the installation of steam power for the purposes of electric lighting. The Chairman stopped the clerk in the reading of the letter, remarking that the town was not likely to go in for electric lighting just at present. Mr. West said the matter might be kept before the Board. It was a question they had talked over with their late surveyor. He thought there was an amount of steam power at the waterworks which might be used for electric purposes. The Chairman said he did not feel particularly interested in the matter at the present. Electric lighting would cost a good many thousand pounds.

Coast Communication.—Telephonic coast communication has been established in the Wexford division of coastguards at the following stations: Between Rosslare and Rosslare Point, Curracloe, and the Wexford Post Office, through communication (one circuit); between Carnsore and Wexford Post Office; messages from the above-named stations are transferred by postal officials. The instruments are placed in the watchrooms of each of the stations except Rosslare Point, where the apparatus is placed in the chief of local pilot's house in connection with the two lifeboats of the Royal National Lifeboat Institution stationed there. It is in contemplation to join the Tuskar lighthouse with Rosslare coastguard station, distant about seven miles.

Bowness.—At the monthly meeting of the Bowness Local Board, the Clerk referred to an application made with regard to the electric lighting, an agreement having been come to between Mr. Fowkes and the Windermere Local Board. Previously there was an agreement between the Bowness Board, and by that they could take over the lighting at the end of 14 years if disposed to do so, and now the Windermere Board wished to join and be put upon the same footing. The agreements were nearly word for word the same, and provision was made that if when the time came and one Board wished to withdraw they could do so, and the other could effect the purchase separately. Mr. Johnson proposed that they agree to join with the Windermere Board. Mr. Holland seconded, and it was agreed to.

Midland Railway.—Considerable progress has now been made in substituting the electric light for gas at the headquarters of the Midland Railway Company at Derby. The engines and dynamos have been installed in the new building in Calvert-street, about 200 yards from the station, and the lights are worked on what is known as the three-wire system. This enables the engineers to regulate the supply according to the needs. At present there are about 1,000 lamps in actual use, and another 1,000 will probably be added shortly. Probably the supply will be extended throughout the whole of the offices and premises, and the preliminary works have been carried out in contemplation of an ultimate supply of 3,000 lights. The whole of the work is being done under the direction of Mr. Langdon, chief electrical engineer to the Company.

Maidstone.—The action of the Corporation in refusing to undertake the lighting of the town by electricity is already bringing other schemes forward, as one electric light company has offered to take up the project, and find all the necessary capital to carry it out. The offer has not been accepted, and before proceeding further the committee will invite similar offers from other electrical companies By an advertisement this week the Town Council are desirous of obtaining information as to the terms on which a company or firm would undertake and carry out the powers granted to them under the Maidstone Electric Lighting Order, 1892—special regard being had to the system of lighting, the maximum charges to consumers, and the time for which a contract should run or a deed of transfer extend. Information should be sent to Mr. Herbert Monckton, town clerk, by the 10th April next.

Rates at Blackpool.—At a meeting of the Blackpool Electric Committee, held on March 1st, Councillor Pearson presiding, some important recommendations were made respecting the prices to be charged for the electric light when it has been got into working order in Blackpool. The principal recommendation was that the charge for electrical energy should be by meter at 6d. per Board of Trade unit, subject to the following discounts for payment within 28 days: Quarterly accounts up to £5, 5 per cent. discount; £5 to £10, 7½; £10 to £20, 10; £20 to £50, 15; £50 to £100, 20; over £100, 25. The principle was objected to at the Town Council meeting. Unfortunately, Councillor Pearson, who has the electric lighting, had been called away to London, and in his absence the question was referred back for further consideration. It was contended, however, that this scale of discounts appeared to have been arranged for the special benefit of the large public companies, and it is probable that the scale will have to be altered.

Bath Electric Light Company.—In their report, the directors stated that the business had steadily increased, the number of lamps now connected being 6,420, as against 5,000 at the end of 1891. Notwithstanding an increase of over £800 from the receipts for current supplied to private consumers, there was a loss of £300 on the year's trading, this being due to the large number of consumers still being supplied by contract, at a loss to the company, instead of by meter. An all-day current was now provided, and the directors were terminating the contract system as quickly as practicable. In moving the adoption of the report, Mr. Garcke (London) said, under the contract system, many customers used the all-day supply excessively, and without advantage to the company, whereas under the meter system there was an inducement to customers to use the current economically. There were instances where the amount paid by customers since they had rented by meter was less than they paid formerly by contract. The report was adopted, and other business transacted.

A Monster Accumulator.—The Tudor Accumulator Company tabulate the following particulars with regard to their largest type of cell:

Useful capacity for ordinary work (five hours)	27,200 ampere-hours
Maximum charging current	4,800 amperes
,, discharging current	7,680 ,,
Length of cell	235 centimetres
Width	152 ,,
Height	120 ,,
Weight of electrodes	4,170 kilogrammes
Total weight without acid	6,078 ,,
Acidulated water	1,940 ,,
Total weight (nine tons)	9,018 ,,
Price (£395)	9,936f.
Packing	323f.

This enormous cell contains 50 kilowatt-hours, and can give out nearly 10 kilowatts—a progress from Planté's little cell!

Gartloch Asylum.—At a meeting of the Glasgow District Lunacy Board held last week, the principal business was to consider the system of lighting which should be adopted at the new Gartloch Asylum. The minutes of meeting of sub-committee were submitted, giving a comparative statement, prepared by Messrs. Mavor and Coulson, of the probable capital and annual expenditure of electricity and oil-gas. The estimated cost of electric plant, exclusive of building, was £7,000, and the annual expenditure £841. Oil-gas was estimated at £755—a saving of £86. Bailie Morrin thought the committee had stepped out of their way in asking the electrical engineers to give a comparative estimate of the cost of electricity and oil-gas. Mr. Baxter gave figures which showed a saving of £11 a week were oil-gas adopted. Bailie Bowman was of opinion that electricity would be a great improvement on either coal or oil gas, and some day would be as cheap as either. After discussion, the chairman moved that the system of electric lighting should be adopted. Bailie Bowman seconded. Mr. Baxter moved as an amendment that the matter should be delayed, and schedules issued to electric and oil-gas companies for estimates of plant for lighting and heating to be submitted to a subsequent meeting of the Board. On a vote being taken, Mr. Baxter's amendment for delay was adopted by seven to five.

Arc v. Incandescent.—Mr. S. F. Walker, discussing the question of arc lights *v.* incandescent lamps for street-lighting, quotes the figures published by the St. Pancras authorities of the cost the arc lamps used for street-lighting as being instructive He says: "They are: carbons, £154. 11s. 7d.; attendance, £191. 0s. 1d.,; and repairs, £13. 12s. 6d. These figures appear to cover a period of 13 months, during nine months and a half of which only 28 lamps were in use; during a further two months 44 lamps and for the last fortnight the full 86 lamps. It is not easy on these figures to strike an average of the actual cost per lamp per annum, but they show clearly that the charge must be very much heavier than Mr. Harpur and Mr. Massey have assumed. It must be remembered that, besides the charges given above, those for generation and distribution of current, etc., have to be borne, and further, that nearly the whole of the £359 odd would be extinguished if large incandescent lamps were used. The item £13. 12s. 6d. for repairs to lamps during the first year's working, and during the greater part of which only a third of the lamps had been in use, is particularly instructive." The exact comparison cannot be got quite so simple in this way; there is the comparative cost of current—a point Mr. Walker does not go into. There is, however, a good deal to be said for the use of large incandescents.

Folkestone.—The Folkestone Town Council propose to take over the tramway between Hythe and Sandgate from the South-Eastern Railway Company and turn it into an electrical railway. The Leeds Tramway Company have supplied particulars, and the subject was considered in committee, and the consent of the Council given. The following report of the proceedings was drawn up by the town clerk: "Mr. Sellon, the engineer to the company, explained fully the details of the manner in which the tramways are worked, in particular that the posts would be 120ft. apart, to be varied if a source of nuisance, and the wires 21ft. 6in. above the level of the road; that ordinary tramcars would be used, and the fares would not exceed those at present charged, but would in all probability be reduced; that the company would undertake to light with electricity the route of the tram from Beaconsfield House to the Red Lion at a cost per lamp not exceeding the amount at present paid to the gas company per lamp. That it was proposed, if satisfactory terms could be arranged with the South-Eastern Railway, to light the Seabrook-promenade with the electric light (about seven or eight lamps); that the company would be prepared to supply any number of lamps not in the route the Council might require, at the usual price of about 1s. per lamp per night; that the speed would not exceed eight miles per hour, and the cars would run during the winter months." These proposals were deemed by the meeting as most satisfactory, and a committee was appointed to go to Leeds and inspect the working of the tramway there, the cost of the visit being defrayed by the Council.

Victoria.—The Australian *Engineering Journal* has an article on the Union Electric Lighting Company, Victoria. "Depression may be great in the colony, but it certainly is not in electrical matters," said Mr. F. Draper, of Draper and Sons, of Melbourne, to their representative, who goes on to say: "A stroll over the place was not of long duration, but it served to show very clearly that a large business may radiate from a comparatively small centre, and we were pleased to learn that the firm contemplate considerable extension. Mr. Draper, jun., who has had a thorough training at the works of the Thomson-Houston Company, Lynn, near Boston, U.S.A., imparted a few particulars of the works which may be of interest. The old station is situated off Lonsdale-street, and has two boilers with a capacity of 250 h.p to drive the dynamos. There are two arc dynamos, each supplying 35 lamps of 1,200 c.p. per lamp, and three alternating dynamos which give 700 lights of 16 c.p. each. In addition to this, the firm work another arc dynamo for illuminating the exhibition building. The increase of business has been so satisfactory that a new station has been rendered necessary, and is now in course of erection on the opposite side of the street. Two boilers will be put in for the present; one is an 80-h.p. Robey triple-gear engine, and the other a 120-h.p. Westinghouse, and these two will admit of a lighting capacity fully equally to that now obtained. It is, however, contemplated to extend the new premises, and lay down 12 boilers, which will develop 1,800 h.p., equal to about 20,000 16-c.p. lamps. In addition to electric lighting, the firm do an extensive trade in telephones and other appliances peculiar to electricians." The hints herein conveyed as to activity of electrical trade and of American manufacturers to provide for it, should not be without its effect on our own engineers.

Newbold Revel.—Extensive structural alterations are being carried out at Newbold Revel, which is being fitted throughout with electric light, to the complete exclusion of gas. The generating plant, which is being placed in a specially-constructed engine-house, situated about 300 yards from the main building, consists of two boilers of the Cornish type, each boiler being 24ft. long by 5ft. 6in. in diameter. These boilers supply steam at 100lb. pressure to two combined sets of engines and dynamos of the latest pattern, Parsons steam-turbine type, running at a speed of about 5,000 revolutions per minute. Each set of engine and dynamo will indicate about 50 h.p., and will be capable of running 500 incandescent lamps at one time. In addition to the engines and dynamos, accommodation is also provided for accumulators capable of supplying 350 16-c.p. incandescent lamps for eight hours when the engines are at rest. Current will be supplied to the house, stables, and laundry, fire-engine house, kennels, new bath-house, gymnasium, and racquet court, gardener's cottage, and refrigerating machinery, which latter is to be driven by an electric motor of 1½ h.p. Five independent underground main cables will be used to connect the above to the engine-house, these consisting of concentric copper conductors insulated from one another, and protected by an armouring of steel tapes. The total weight of these underground cables will be about 12 tons. The total number of lamps now being fitted is about 560, varying in size from 8 c.p. to 50 c.p. each. The installation is being arranged by Mr. A. A. C. Swinton on similar lines to the plant recently completed by the same engineer for the Earl of Durham at Lambton Castle. The use of searchlights on the top of the house for ornamental purposes has been suggested, but at present the question is in abeyance.

Eastbourne Parade.—At the Eastbourne Town Council meeting last week, Councillor Towner moved that the committee's recommendation for lighting the Royal-parade by electricity, instead of by gas, be not agreed to. He said the Royal-parade was the best-lighted part of Eastbourne. There were nine Sugg's lamps and eight smaller ones, making an average of one lamp to every three houses. Electricity would involve an excess over the present outlay of £57. 15s. Instead of increasing the expense, he thought it would be better to think about reducing it. Councillor Job said he was one of the sub-committee appointed to go into the matter. They were instructed on the basis of a recommendation from the Finance Committee, who considered that the entire parade should be lighted by electricity. The matter was referred to himself and Councillors Duke and Easter. Unfortunately, Councillor Easter did not attend, and he (Councillor Job) and Councillor Duke went into the matter with the surveyor, and considered it would be beneficial and right to substitute electricity for gas, especially considering the high ground rents which the leaseholders were called upon to pay. Alderman Strange said he did not agree that the Sugg's light was superior to the electric light, and, seeing that the owners did pay a heavy ground rent, the Corporation, as landlords, ought do their best to increase the popularity of that end of the town and make the houses remunerative. The Deputy Mayor thought the Corporation would be open to the charge, being owners of the ground at the Royal-parade, of conferring advantages on their own property if they adopted this recommendation. The houses in other parts had just as heavy ground rents, and though the Council might be doing their duty to the tenants on the Royal-parade, they would certainly not be doing their duty to the inhabitants of the town at large. Councillor Wenham submitted that they were not asking for any additional benefit, but only to be put on a level with the other portions of the seafront. On a division the amendment was lost, and the report of the committee was agreed to. Electric light will therefore be adopted.

City and South London Electric Railway.—A Bill promoted by this Company came, on Monday, before Committee of the House of Commons with Sir John Kennaway in the chair, to extend their existing line from the City station at King William-street to the Angel at Islington. The proposed additional service would be carried over the present railway to the City and pass under the King William-street to a new station at Lombard-street, and thence by new line to stations at Moorgate-street, Old-street, City-road, and Islington. The current line was said by counsel for the promoters to have surmounted all obstacles, and temporary stoppages which were incidental to new electric lines, and the success had been so great and so rapid that the difficulty was to carry all the traffic which dropped on the railway. Something like 12,000,000 passengers had been carried since the line was opened in 1890. Power was taken in the Bill to connect by foot subway with the Brighton and South-Eastern at London Bridge, and to connect with the Oxford-street line. By a separate Bill it was intended to extend in a southerly direction from the present terminus at Stockwell to Clapham Common. Appearances against the Bill were nominally entered for watching purposes by the London County Council, the City Corporation, and others, and more actively by owners of property on the route. Evidence in support of the Bill was given by Mr. Greathead, the engineer, who stated that the gradients on the new line would be 1 in 90, as compared with 1 in 30 on the existing system. The line would be cut through the London clay at a depth of from 50ft. to 100ft. below the surface, as against the 50ft. of the present system. The average speed would be about 14 miles an hour, including stoppages. The total cost would be £706,633. The tunnelling for the line would involve no danger to the fabric of the Bank of England. The committee, after hearing the evidence, declared the preamble proved, and deferred the consideration of clauses to provide for compensation in case of damage to property by the construction or working of the railway. The committee also declared proved, in the absence of opposition, the Bill for extension of time for the construction of the line from Stockwell to Clapham Junction.

South Staffordshire Tramways Dinner.—The ninth annual dinner of the employés of the South Staffordshire Tramways Company took place in the Town Hall, Darlaston, on Wednesday last week. Mr. W. J. Carruthers-Wain presided, supported by Messrs. J. Wheway (Mayor of Walsall), L. H. Partridge, G. Rose (Town Clerk of Wednesbury), J. Corbett (clerk to the Darlaston Local Board), W. G. Leckie, A. Dickinson, H. Hatchett, Walklate, Holmes, Long, Dickinson, and others, the company numbering about 240 persons. After the toast of "The Queen" had been honoured, the president gave "Prosperity to the District," and acknowledged the support given by the authorities of the district to the company's undertaking. The Mayor of Walsall, in responding, said that Walsall was much indebted to the company for the facilities afforded to the community, and they could not do less than wish prosperity to the company. The Town Clerk of Wednesbury, in giving "The Chairman and Directors," said those gentlemen were distinguished not only by energy, but by extraordinary enterprise. They first of all in that district introduced steam trams; they had introduced a novel system of electric traction; and in the near future they were going to tackle the cable. They endeavoured to make the lot of the tramway servants as pleasant as possible, and as the result of their work and enterprise that district had the best means of locomotion of any in England. The Chairman responded. In referring to the proposed substitution of cable for steam in Handsworth and West Bromwich, he expressed a hope that the authorities of those parts would appreciate the enormous conveniences and comforts which would be brought to the inhabitants of the district by the change, and would do all in their power to help the company in the task which had been undertaken. The directors had not been able to make a dividend for the shareholders, but they had provided travelling conveniences for millions of passengers, who had been carried by the instrumentality of the men he saw before him; and he took the opportunity of publicly acknowledging the indebtedness the directors and the shareholders felt to their staff for the magnificent manner in which they had done their work and conducted a traffic so large with accidents absolutely trivial in comparison to the great service rendered to the public.

Electric Tramways in Berlin.—The question of electric tramways in Berlin, according to an article in *Kuhlow's Review*, is attracting much attention, which is natural enough in a town of this description, with its level and straight streets, and where the horse trams already account for such a great portion of the traffic. The matter is, however, still in a somewhat unsettled state. The great plan of Messrs. Siemens and Halske of an extensive system of underground electric tramcars, put forward some 12 months ago, was at first very favourably received, but doubts soon arose as to the suitability of the ground. It was decided not to grant the concession till an experimental section of tunnel had been completed. A site was placed at the disposal of the firm, but nothing more appears to have since been heard about this project, instead of which the same firm has worked out another, substituting overground electric cars instead of the underground. This latter plan at once met with a good deal of opposition, which seems of late to have somewhat abated. It appears that the municipal authorities are willing to accept it, with the Emperor's consent. This electric railway is in the first instance proposed to proceed from Warschauer Brücke to the Zoological Gardens, and the construction is to be lighter than that of ordinary railways. There will be two electric motors for each passenger car, as Siemens and Halske do not approve of independent electric locomotives. The advantages of the former system—equal load for all carriages in the train, uniform propulsion, increased adhesion between wheels and rails through the weight of the passengers, etc.—far outweigh, they think, the advantages of the latter. This system is also better for the road, the wheel-pressure being only one-fifth of what is the case with a locomotive. There will be no stations, simply platforms, with steps down to the level of the street. Apart from this plan, the already existing tramway lines—and Berlin has an uncommonly good system of horse trams—may ere long be transformed from horse to electric tramways. The authorities have decided that exhaustive trials with accumulators should be undertaken so as to ascertain the possible suitability of this system, before any experiments are made with underground supply. The large Berlin horse tramway company is going to give the accumulator system a fair trial, a charging station being in course of construction at their Schöneberg station. The Berlin-Charlottenburg horse tramway will probably also be altered and electric power adopted.

London Electric Railways.—In the House of Commons on Thursday last week Mr. Pickersgill rose to move that it be an instruction to the Committee on the City and South London Railway Bill that they do insert a clause reserving to the London County Council a power to purchase the undertaking after the expiration of a limited period, on terms similar to those provided in Section 43 of the Tramways Act, 1870. Identical notices appeared on the paper in the name of the hon. member in regard to the following projects: Clapham Junction and Paddington Railway, Edgware-road and Victoria Railway, Hampstead, St. Pancras, and Charing Cross Railway, and Waterloo and City Railway. He said he had placed these notices on the paper at the request of the London County Council, representing some 4,000,000 people. There were now before the House a batch of electric railways by which it was proposed to provide London with a series of underground communications in various directions. The Council had authority over everything which would be traversed by these companies, and he asked the House to affirm the principle that the Council, as the local authority, should be empowered to acquire these undertakings upon fair conditions at the expiration of a certain term of years. The joint committee before whom these projects came last year made no reference to the subject of purchase. The public had a right to the subsoil of the streets to any depth which might be required for public purposes. If the means of locomotion at a depth of 60ft. could be considered a public purpose, the public ought not to part with that right without some compensation. The principle of giving the public rights to acquire railways was established in 1844, and what he asked now was the affirmation of that principle, leaving it to a committee to take evidence as to the number of years to be fixed. Mr. Boulnois, opposing the motion, maintained that questions of this kind were not adequately discussed by the London County Council, at whose meeting the closure was freely applied. The Council would destroy private enterprise, to which the nation owed so much; but he hoped that this octopus, with its greedy and grasping antennæ, would be restrained. Mr. Stansfield, as chairman of the committee appointed to make general suggestions for dealing with Bills like this, declared that they had concluded that sufficient cause had not been shown for expressing an opinion in favour of the course now proposed by Mr. Pickersgill. Sir J. Lubbock thought the House had better let the Bill go to a select committee without hampering them with the proposed instruction. On a division there were 129 for and 242 against the instruction.

Weston-super-Mare.—At last week's meeting of the Weston Local Board, a letter from the Brush Company was read, suggesting a representative should wait on the Board and submit a proposition. The Clerk read a letter he had sent the company on the 11th February, 1893, stating that he was instructed to inform them that the Board was open to consider a proposal for the transfer of their provisional order to a local company to be formed by them, but that any proposition for payment of a goodwill at valuation on the expiration of the term fixed would not be acceptable. Mr. Phillips proposed that the matter be deferred until the destructor question had been disposed of. Mr. Gill thought, supposing the destructor was to be erected near the waterworks, and was of the kind which might be used for electrical lighting purposes, they would have something worth offering the company. It would be then for the company to consider the value and to base their terms to the Local Board. Mr. Pethick did not think the position was quite understood. They had agreed to postpone the consideration of their undertaking the question of electric lighting until they had settled about the destructor. The company simply wished to make an offer, the Board need not accept or entertain it; they were not taking any steps in the matter. They had given the company this hint because the agent that came down seemed to throw out a hint that the terms would be subject to some compensation in case of the company taking over the right and the Board resuming their privilege at the end of 21 years. The Board, in reply, stated that no proposition such as that involving compensation would be favourably entertained by them. He was in favour of the company's representative coming down and to hear what he had to propose. Mr. Harvey concurred. If the company came down and wished to give some information, the Board could receive it, and no harm need be done. Mr. Shorney thought the Board only wanted to know which was the best method: whether to let the company take the right over, or to exercise it themselves. The Clerk stated that the provisional order expired in June. Mr. Beedle was of opinion that they had to learn a good deal on electric lighting, and on their mode of action; if the company volunteered information they should accept it. The interview might make a difference as to their selection of a destructor. There could be no harm in getting all the information they could. They had a lot to learn, and only three months to do it in. He did not know whether they should get an extension of time. Mr. Pethick moved that the clerk be instructed to write the company, and say that the Board will be happy to meet the manager and hear anything he may have to say. Mr. Beedle seconded the proposition, which was duly carried.

Sunderland Lunatic Asylum.—At the meeting of the Sunderland County Council last week, the Visiting Committee of the Borough Lunatic Asylum reported that they had accepted the tender of Edmundson, Limited, of Westminster, for executing works in connection with the lighting, heating, ventilating, etc., of the borough lunatic asylum by means of electricity for the sum of £4,083. Alderman Shadforth, the chairman of the committee, moved the adoption of the report. He said that for some time past the committee had had under very serious consideration the question as to whether to adopt electric lighting for the new asylum as against gas. Their own architect calculated that at the first outset the introduction of electricity would mean an extra expense of £1,500 over gas, but they had come to the conclusion that, although there might be a little extra cost, yet, as regards working expenses, it would be cheaper than gas, inasmuch as the gas company asked 2s. per 1,000ft., or 6d. more per 1,000 than the Council were paying them in the town. They also thought that the building being a modern one, they should have the most modern appliances, and were fully sure that the adoption of a mode of electric lighting would save cost in cleaning, in addition to adding to the comfort of those who would have to live in the asylum. There had been four tenders sent in for the lighting, and after due consideration it was decided to recommend that that of Edmundson should be accepted. An amendment was moved to defer the lighting. After some discussion, Alderman Shadforth proceeded to reply to the questions asked by the members. He emphasised the fact that the committee had acted on the best advice that could be obtained. It had been shown that the consumption of the gas in the asylum would amount to 184,000ft. per annum, and that would cost something like £600. If they adopted the system of electric lighting which the committee had just put forward the working cost would be about £400, but in addition to this they would have to take into consideration the cost of the glass globes, which now amounted to 3s. 6d. each, but which in the course of a month or two would be reduced to 1s 6d. or 1s. each. The actual saving would be about £200. The committee were surprised when they learnt this, and that was the reason they asked for tenders. Of course, they would have to have some motive power, and steam was what would be provided for, by placing an additional boiler in the laundry, where provision had already been made for two. If the matter was adjourned the general work of the building would be stopped. That there was a material saving in the cost of cleaning and painting by the use of electricity instead of gas had been proved in the case of the Exeter asylum, which had been lighted with gas for several years. There was really no tender from a local firm, and the firm selected was an old-established one. Mr. Roche supported the resolution. It seemed to him that the matter had been carefully gone into, and even if it were shown that the electric light would cost rather more than gas, he considered they should go in for it. Even if it were shown that there would be no saving in painting and cleaning he would go in for it. They were erecting a modern institution, and surely they were going to be up to date. The resolution to introduce the electric light was eventually carried by a large majority.

Cardiff.—The *South Wales Daily News* has at last caught and interviewed Mr. Massey with reference to the proposal which has been put forward that the water power available from the waterworks system of Cardiff should be first utilised before the more expensive agency of steam is called into requisition. "The basis of calculation is simple enough," he said. "Taking the total amount of water which is actually collected in the gathering-ground and multiplying that into the total height between Cardiff and the highest reservoir—call it 1,000ft.—you will find that this supply does not equal more than a regular flow of four million gallons during the 24 hours. When a proper allowance is made for loss in the 30 miles of mains, the energy available for turbines is, nevertheless, most certainly worthy of being considered, provided that there were no practical difficulties in the way. But you may take my word for it that owing to the waterworks being laid out as they are, and there being so many other practical difficulties to be faced of a nature that outsiders cannot be expected to take into account, it would be far better to put an end to the project altogether than to depend upon the water power at your command to carry it on. It must not be forgotten that we started with the idea of using the water power, and we have resolved all along to utilise it when convenient. But this must not be to begin with, because the total available energy from that source forms an insignificant part of the whole horse-power required to light a town like Cardiff. It is certainly desirable, from the ratepayers' point of view, to call in the aid of a cheap power when it exists, and this will be done, but it will only be available as the electric lighting mains are extended towards those points where the water power is best obtainable. However, four million gallons daily mean about 1,666,000lb. weight per hour. We found out just now that a pound of coal would do the work of nearly one million foot-pounds. That is the potential energy; 75 per cent. of the available water pressure gives 1,250,000lb., therefore the available energy of the entire water supply of the town is about equal to 1¼ times the energy to be extracted out of 1lb. of coal per hour. Over 1,000ft. of fall that would mean a saving by using water power of about 1,250lb. of coal per hour, or 13 tons during 24 hours. You know the price of coal, so it is an easy matter to figure out the result for yourself, and you must bear in mind that all my calculations are in favour of the water. There are a hundred to one considerations which, in actual practice, would diminish the amount of the water-force, and thus decrease, in corresponding ratio, the available energy for electric lighting purposes. Light for light and hour for hour, the electric light in Cardiff will cost 2½ times as much as gas at its present price. Therefore, from the strictly economical point of view, the electric light is not so cheap an illuminant as its rival, but it is so vastly superior in every other respect that its efficiency far more than makes up for its cost. For household purposes it can be reduced almost to the price of gas. By the judicious use of switches, householders may turn off the light at will when they do not require it, whereas gas is more generally left burning. It is our intention to use incandescent lamps of high candle-power in some of the by-streets, and arc lamps in the main thoroughfares; but, of course, we will drive both by the same plant. These matters would be settled much more easily and smoothly if people would not make random statements about things they do not understand. I assure you the Corporation Committee and myself have gone into every detail with the utmost care. We have rejected no suggestion without submitting it to the most careful scrutiny, and the result will be that the system finally applied to the lighting of Cardiff will be absolutely the best in the market." The Local Government Board enquiry as to the local electric lighting scheme has been fixed for the 14th inst., when the whole subject will be gone into thoroughly.

Belfast.—Prof. Alexander B. W. Kennedy, F.R.S., has furnished the Belfast City Council with an elaborate report regarding the proposed electric lighting of the city. After mentioning that he has carefully examined the streets and buildings, and inspected several possible sites for a central lighting station, he states that he has been compelled to make his own estimates as to the probable demand for electric light in the city, based upon observation and his experience in other places. Within two or three years of the starting of the works the Corporation may have to supply current to the equivalent of about 8,500 lamps of 8 c.p. each, wired in the central district, while in the southern district there may be 4,000 lamps of 8 c.p. required. In the one case it would be amply sufficient to provide for 6,100 lamps alight at the same time, and in the other for about 1,400 such lamps. Each 8-c.p. lamp in the central district will use about 17·5 units per annum, and in the southern district about 11·5 units. If the rate of charge be 6d. per unit, the income per lamp would be 8s. 9d. and 5s. 9d., and the total income £3,850 and £1,200 respectively per year. The maximum rate at which electrical energy would have to be delivered to consumers would be about 200 kilowatts and 45 kilowatts rsspectively; these being the figures which govern in connection with each particular system of generating plant the dimensions of the engines and dynamos. There is no difficulty in dealing with the central district, which includes all the first-class shops, clubs, and banks, and business concerns, but outside this there is a ring, having a breadth of three-quarters of a mile, covering the industrial part of the city, and there would not be much demand for electric light there unless the work could be carried out on such a large scale as to reduce its price very much below anything at present possible. To put the electric and gas supplies on something approaching equal terms would require the expenditure of ten times the capital estimated for, and no electric light scheme short of a great one such as this would serve to sensibly relieve the pressure on the existing gasworks. Beyond the "industrial ring" are the residential districts, northern and southern; and while only dealing directly with the southern, the system best adapted for it can be applied later on in the northern, as the conditions are almost identical. The southern district could be most cheaply supplied with electric energy, by a high-tension alternating-current system with a separate transformer on the premises of each consumer. Unfortunately, there does not exist (except on paper) any satisfactory means of cutting these transformers out of circuit when they are not in use. The effect on the economy of the station of leaving them always on circuit is so considerable that the Corporation is recommended to expend an additional £1,500, the extra cost of laying high tension distributing mains, which is undoubtedly the best system for the central district. Of the available sites for a central station, either one in Ormeau-avenue or one at the River Lagan, immediately below the Albert Bridge, would serve perfectly for generating high-pressure current, but the riverside would be out of the question for a low-pressure system. Prof. Kennedy, however, works out a scheme entirely different from that in vogue in any part of England or Scotland. The object of this is that the Corporation may gain the economy involved in the use of batteries at a cost very much less than that of a direct three-wire system from one central station in the usual way. This could be achieved by means of sub-stations containing continuous-current transformers on the Oxford system; but after the most complete consideration, he believes the most economical and advantageous form of sub-station for Belfast is one in which the dynamos are driven by ordinary gas-engines, using town gas, which costs 2s. 3d. per 1,000 cubic feet. The central sub-station would be the headquarters of the system of distribution, containing two gas-engines, each of about 50 i.h.p., with corresponding dynamos, and would contain also a battery of moderate output—say, about 500 ampere-hours capacity—besides all the principal regulating apparatus and instruments, and would be always at work when it would be necessary for any machines to be running at all. The central station would not always be at work, although the use of gas-engines would allow its machinery to be started at any moment if required. Even in winter it would only be necessary to have it open for one watch per day. It would contain the plant for taking up three-fourths of the load, together with all reserve plant, which would occupy more space than could be found conveniently in the centre of the city. If the demand for electric light varied in the same proportion as gas, it would be unnecessary to run the c station at all during three or four months in the year. A basement space having an area of about 750 or 800 square feet (or less if direct-driving engines could be obtained), situate in the centre of the city, would entirely serve the purposes of the sub-station. The merits of ordinary coal *versus* generator gas are discussed in favour of the former, showing how the southern district of the city could be worked by two sub-stations connected with the central station. Prof. Kennedy estimates the total cost of the scheme recommended, exclusive of land, buildings, and meters, but inclusive of the whole of the plant and machinery, mains and road work, at about £19,000 for the central district, and at about £11,000 for the southern The latter includes about 10,200 yards of road work, nearly double the amount in the central district The actual station expenses, including salaries, wages, gas, stores, and repairs, when 8,000 lamps would be wired, should be about 3d. per unit sold. Expenses of management, rent, rates, and taxes, interest and sinking fund, and a necessary and proper allowance for depreciation, would add 3d. per unit more to the cost. Prof. Kennedy therefore thinks it not unreasonable that the Corporation should start the electric supply with a charge of 7d. per unit, but adds, that as so large a proportion of the total costs are practically fixed charges—salaries, wages, rates and rent, interest and depreciation—the very best way to reduce the cost per unit is to increase the number of units sold. From this point of view the Corporation would no doubt consider very seriously whether it would not be the wiser policy to start with a charge of 6d. per unit at once in order to raise the output as soon as possible. These are the main features of Prof. Kennedy's exhaustive report, which is under the consideration of the Gas Committee of the Belfast Corporation.

PROVISIONAL PATENTS, 1893.

March 6.

4793. **Improvements in the construction of the reel and battery box in connection with portable electric bells.** John Obadiah Brooke, 21, King-street, Wakefield.

4818. **Improvements in the construction of electric light switches and cut-outs.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electric Works, Salford, Manchester. (Complete specification.)

4827. **An electric alarm for automatically signalling when lubricators are empty.** Joseph Pollit, Eustace Wigzell, and George Meddings, Billiter House, Billiter-street, London.

March 7.

4869. **Improvements in the process of obtaining chlorates of the alkalies or of the alkaline earth metals by electrolysis.** William Taylor Gibbs and Stanislaus Paschal Franchot, P.O. Box 1,071, Ottawa, Canada. (Complete specification.)

4871. **Improvements in electric batteries.** Nestor Rolland, Norfolk House, Norfolk-street, Strand, London.

4874. **Improvements in the transforming and conversion of electric currents.** Herbert Fraser Foster, 64, Cornwall-road, Westbourne Park, London.

4910. **An improvement in electric switches.** Edward Lionel Joseph and Appleton, Burbey, and Williamson, 115, Cannon-street, London. (Complete specification.)

4911. **An improvement in contact-makers for electric lamp-holders.** Edward Lionel Joseph and Appleton, Burbey, and Williamson, 115, Cannon-street, London. (Complete specification.)

4912. **Improvements in the construction of spring buffer-connections for the holders of electric lamps.** Edward Lionel Joseph and Appleton, Burbey and Williamson, 115, Cannon-street, London. (Complete specification.)

4923. **Improvements in conductors in telescopic standard lampholders for electric lamps.** Anthony George New, 12, Palace-chambers, Westminster, London. (Complete specification.)

4938. **Improvements in incandescent electric lamps.** Gilbert Scott Ram, 32, Oakley-square, London.

4941. **Improvements in and relating to signalling on railways, and in telegraph relays for use in connection therewith, and for ordinary telegraphic purposes.** Josef Tuma and Edmund Von Motesiczky, 46, Lincoln's-inn-fields, London.

4952. **Improvements in electrical relays and measuring instruments.** Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

4976. **Improved apparatus for working railway switches by means of electrical energy.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

March 8.

4992. **Improvements in electric lamp-sockets and like electric fittings.** Hugh Hirst, 13, Banyard-road, Southwark Park, Bermondsey, London.

5051. **Improvements in primary batteries.** Theophilus Coad, 1, Quality-court, Chancery-lane, London.

5064. **Improvements in electric clocks.** Jules Cauderay, 24, Southampton-buildings, Chancery-lane, London.

March 9.

5084. **An improved method for fastening electrical conductors, wires, cables, and the like in wood casings by means of adjustable clips or clamps.** Ernest Cockburn Day, 362, St. Vincent-street, Glasgow.

5101. **Improved system of electrically interlocking signals and points, and in apparatus therefor.** George Edwin Fletcher, 4, Clayton-square, Liverpool.

5109. **Improvements in and relating to the methods and means of coupling alternating-current dynamo-electric machines in synchronal relation, and maintaining them in that relation.** William Lowrie, 117, Bishopsgate-street Within, London.

5110. **Improvements in and relating to apparatus for charging electric accumulators.** William Lowrie, 117, Bishopsgate-street Within, London.

5142. **Improvements in incandescent electric lamps, and in apparatus connected therewith.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

5143. **Improvements in microphones.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

5171. **An improved electric safety lamp.** Donato Tommasi, 53, Chancery-lane, London.

5181. **An improved combined lamp and electrical igniting device therefor.** Jules Lang, 45, Southampton-buildings, Chancery-lane, London.

March 10.

5197. **Improvements in the production of alkali and in apparatus therefor, the said apparatus being applicable for electrolysis generally.** James Hargreaves and Thomas Bird, 4, Clayton-square, Liverpool.

5198. **Improvements in and in making electrolytic apparatus.** James Hargreaves and Thomas Bird, 4, Clayton-square, Liverpool.

5261. **Improvements in electric belts.** Robert Davy Bowman, 22, Southampton-buildings, Chancery-lane, London.

March 11.

5337. **Improvements in conductors for electric railways.** James Alfred Ewing, Langdale Lodge, Cambridge.

5339. **Improvements in and relating to alternating-current electric motors.** Robert Lundell and Edward Hibberd Johnson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5340. **Improvements in and relating to alternating-current electric motors.** Robert Lundell and Edward Hibberd Johnson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5341. **Improvements in or connected with electric batteries.** Charles Percy Shrewsbury, Frank Lawrence Marshall, John Cooper, and John Laskey Dobell, 57, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

1391. **Coating articles by electro-deposition.** London Metallurgical Company, Limited, and another. (Amended.)

3112. **Electric meters.** De Ferranti.

5186. **Electric arc lamps.** Lenczewski.

6088. **Incandescent electric lamps.** Boehm.

6465. **Secondary batteries.** Heyl.

6720. **Dynamo-electric machines.** Kingdon.

6911. **Electric arc lamps.** Davy.

7037. **Electric arc lamps.** Belfield.

7252. **Electrical distributing apparatus.** Crompton and Chamen.

1893.

387. **Electric launch and sailing vessel.** Bowen.

471. **Electric motors.** Allison. (Hering.)

517. **Measuring electric currents.** Lake. (Weston.)

518 **Measuring electric currents.** Lake. (Weston.)

520. **Measuring, etc , electric currents.** Lake. (Weston.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3 3/16
— Pref.	—	2 3/16
City of London	—	12¾
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	5⅞ 4¼
London Electric Supply	5	¾
Metropolitan Electric Supply	—	5½
National Telephone	5	5¼
St. James'	—	8
Swan United	3½	3½
Westminster Electric	—	5¾

NOTES.

Manganese.—Important beds of manganese have been discovered in Transcaucasia.

Incinerator.—The *Indian Engineer* gives in its issue for February 25 a plan of Garlick's regenerative incinerators.

Carbon as Fuel.—The unburned ends of arc-light carbons are said to make excellent fuel when mixed with anthracite coal.

South African Telephones.—A telephone line has been laid between Leydsdorp and the Silati goldfields, and is now in full working order.

Patent Index.—Indexes to patents relating to electricity covering the period from 1882 to 1890, have been issued by the American Patent Office.

Train-Lighting. — Pintsch's system of train-lighting is being adopted on the Indian railways practically without opposition as yet from electric lamps.

Artificial Diamonds.—M. Moissan will repeat his experiments on the artificial production of diamonds in public before the annual meeting of the Société Française de Physique.

Kew.—The post of superintendent of the Kew Observatory is vacant. Printed particulars will be forwarded on application to the Assistant Secretary, Royal Society, Burlington House, W.

Church-Lighting in Glasgow.—The first church in Glasgow to be lit by electricity from the Corporation mains will be Free St. Paul's, North Frederick-street. Six lamps, each of 200 c.p., will be used to light the centre of the church.

Journalistic.—Mr. Edward Caldwell, lately in charge of the editorial department of the *Electrical World*, has now taken charge of the *Street Railway Gazette*, which is changed in style and form, and will be a weekly street-railway paper.

North Staffordshire Mining Institute.—A meeting of the members of this institute was held at Stoke-on-Trent on Monday evening, Mr. R. H. Cole presiding. Mr. W. M. Mordey delivered an address on "Electric Lighting and Transmission of Power by Electricity."

Waterloo Electric Railway.—The postponement of the consideration of the suspended Bill of last year for powers to construct an underground electric railway from Waterloo Station to Mansion House-street, has resulted in the withdrawal of the opposition of the South-Eastern Railway Company.

Royal Institution.—Among the lecture arrangements after Easter for the Royal Institution are three lectures by Mr. Jas. Swinburne, on "Some Applications of Electricity to Chemistry" (the Tyndall lectures). Subsequent discourses will be given by Prof. A. B. W. Kennedy, Mr. Shelford Bidwell, and Lord Kelvin.

Paris Mains.—M. Dieudonné describes in detail in *L'Electricien* for 18th inst. the underground electric mains of the Champs-Elysées section in Paris. The mains are concentric, made by the Société Cail. The normal pressure is 3,000 volts, and the cables are tested to 6,000 volts. The insulation resistance is 4,000 to 5,000 megohms per kilometre.

Indian Telegraphs.—Mr. Finch, director of the Persian Gulf section of the Indo-European telegraph line, has been appointed to the new post, at £1,000 a year, created under the Indian Office, consequent on the Indian Telegraph Department relinquishing the management of the overland lines. His title will be director-in-chief, that appointment being revived.

Getting up Steam.—A Lancashire boiler is regarded preferable to a multitubular boiler when the pressure required is constant, as a quick-steaming boiler is seldom found to give the same efficiency as a Lancashire boiler at heavy load. On the other hand, a Lancashire boiler takes about $1\frac{1}{2}$ tons of coal to get up steam, and a multitubular quarter to half ton.

Electric Storm at Glasgow.—A strange meteorological disturbance occurred on the 16th inst. at Glasgow. There were brilliant flashes of lightning and a terrible clap of thunder, followed by a hurricane of wind and sleet. The lightning caused the telephone bells in the city to ring, and one gentleman who was speaking through the telephone received a severe shock.

Electric Organ.—A new electric organ was opened at Scarborough on Friday evening. A very large congregation assembled to hear the effects of this departure for aiding the musical portion of church worship. The organ is in two entirely different portions of the church. The keyboard is on that portion of the organ near the chancel, and communicates by an electric current with the other portion at the west end of the church.

Colombo Tramways.—Three offers have been received by the Colombo municipality for the construction of tramways in Colombo: from Messrs. Hutchinson (contractors to the Madras Electric Tramway), Messrs. Allan and Co., and Messrs. Irwin and Co. The latter firm, who built the Karachi line, undertake to have the line ready in six months, the others in 12 and 18 months. The consideration of the proposals has been deferred for a short time.

Frequency and Output.—Mr. C. P. Steinmetz, in a series of articles on transformer frequency, states, in the New York *Electrical Engineer*, March 15th, the relation between frequency and output of transformers. He shows that within certain limits the output is proportional to the $\frac{3}{8}$th power of the frequency, and thus establishes for the first time a relationship between these two important elements in transformer design.

Primary Batteries.—A good paper, whose title explains itself, was read before the Franklin Institute by Mr. E. F. Northrup on "Some Principles that Must be Observed in Order to Make a Good Closed-Circuit Battery, and a New Portable Dry Cell described in which these Principles are Applied." It is published in the *Journal* of the Franklin Institute for March. The author discusses electrodes, their forms, the electrolytes, depolarisers, and other parts of a primary cell.

Woodhouse and Rawson.—In our leader last week the question was raised whether money had not been lost, and work scamped, in installation business as well as in company-promotion. We are glad to say that, from the evidence we have had submitted to us, there seems to have been consistently every endeavour made to do the installation work properly; and thus, if a scheme of reconstruction is carried, the past experience and success should be of great service under the new conditions.

N.S.W. Electrical Club.—The Electrical Club of New South Wales held a meeting of its members in the instruction-room at the General Post Office, Sydney, on February 3, when condolence was expressed most sincerely by the members at the loss the club had sustained by the death of Mr. Cracknell, who had held the office of president. Mr. P. B. Elwell was then elected president. Mr. Oswald Haes, M.I.E.E., read an interesting paper, accompanied by diagrams, on "The Electric Lighting of Trains."

Long-Distance Telephones.—A great feat is shortly to be attempted by the telephonic department of the

General Post Office—the laying of a telephone between London and Dublin. Glasgow merchants will also very soon be able to communicate with Belfast by the same means, as a telephone is now being laid between these two great trading centres. In time it is intended to form a complete circuit by which the cities of Dublin, Belfast, Glasgow, and London will all be enabled to have telephonic communication with one another.

Electrically-Welded Shells.—The use of electric welding for the manufacture of projectiles has reached a point of practice in the United States which seems to be considerably in advance of that of other countries for this process. Steel blooms are cast hollow and rolled into a thick tube, cut into short lengths, and then electrically welded to the top, which has been formed with dies. Mr. Hiram Maxim, in the *Proceedings* of the United States Naval Institute, describes the process and the machines; the sheets are made up to 6in. in diameter, and 94lb. in weight.

Micanite. — We have received a reprint of Mr. Thompson's paper on micanite read before the American Institute of Electrical Engineers. This material, it may be remembered, is a built-up substance of cement and mica strips. Photographs of all kinds of micanite insulators are given, of a kind as would seem to be exceedingly useful to electrical engineers—washers, rods, rings, slot insulators, and so forth. Messrs. Eugene Munsell and Co., 218, Water-street, New York, have taken up the manufacture, and issue the booklet, which should interest makers of dynamos and switches.

Incandescent Lamps.—Enquiries are being continually made as to the expiry of patents, and enquirers almost always ask, "What can we do?" A good many people will no doubt have to look more closely into patents, and will find that in some cases the expiry of a particular patent does not leave the road open for free competition. We would ask some of the eager competitors to study the question of lampholders as well as lamps, when they may find that the control of certain forms of holder is bound to play a large part in directing orders and increasing business.

Railway Signalling.—The North-Eastern Railway officials have agreed, the *Newcastle Chronicle* is informed, to give Mr. Simmon's (of Esh Winning) invention for improvements in signalling apparatus a trial on their system. "As soon as convenient, the new apparatus will be put in and tested from Waterhouses passenger station to Flass Junction. Great credit is due to the company for thus giving facilities for a working-man to demonstrate the practicability of his invention, and also for their evident desire—by some such means as this—to avoid a repetition of such sad catastrophies as the late disaster at Thirsk."

Automatic Railway Signalling. — An ingenious system of signalling, says the *Liverpool Courier*, has been invented by the Automatic Electric Railway Signal Company, whose offices are in Liverpool, and who are now exhibiting a model illustrative of the system. This has already been adopted in a railway in the Isle of Wight, and is there working successfully. By this system the passing train works its own signals automatically, and the risk of accidents from any cause is reduced to a minimum. In addition the contrivance is exceedingly simple, and by no means costly either in initiation or maintenance.

Long-Distance Telephoning.—Mr. Herbert Laws Webb has an article in the *Engineering Magazine* for March, on the business advantages of long-distance telephones. He relates anecdotes illustrative of his theme—*how a ten-pound* talk settled a contract for 100,000 chickens; how Chicago ladies talk regularly to their husbands when visiting in New York; and how a New York banker, laid up in Boston by an accident, hired a line and carried on his business by telephone for a week or two. He finds the newspapers quick to use the long-distance wires, and the gain to business men, in spite of the high tariff, very great.

Water-Heater.—A simple home-made water-heater was recently described at a meeting of the Old Students' Association, and the device may prove useful to others. An old boiler was taken, and in this a number of angle-iron strips were riveted with plates of iron, making a kind of circular staircase. Steam was admitted at the bottom and water was allowed to flow, splashing down the steps as the steam rises. The resistance to exhaust steam is very slight, and no blast whatever is needed. The water is heated to nearly boiling point. The heater is placed so that it is level with the boiler, and there is consequently no lifting of the feed-water necessary.

Telephotos.—M. C. V. Boughton is on his way to England to demonstrate the value of his "Telephotos" to the British naval authorities. A long mast has a row of incandescent lamps mounted thereon, which can be lighted in various combinations to represent dots and dashes on the Morse system. The apparatus is worked by a type-writer set of contacts, marked in Morse or Roman characters. An ingenious arrangement locks the other keys when any key is depressed. The whole outfit, with engine, boiler, and dynamo, keyboard and signals for marching service, weighs 1,500lb. The signals can be read at a distance of three miles in the daytime, and 10 miles at night.

One Man-Power.—Mr. J. E. Emerson once, when 22 years of age, at the Manchester Machine Company, for a freak, tried how much iron he could handle in a working day. He lifted, and piled in heaps 4ft. high, 212½ tons of pig iron lumps, varying in weight from 60lb. to 150lb., and had the last pig on the pile as the whistle blew—as he says, "about as used up a man as ever lived at the end of 10 hours' work." Taking the mere act of lifting alone an average of 2ft., this would give 952,000 foot-pounds in 600 minutes, or one-twentieth of a horse-power. Adding the act of carrying, say, as much again, his man-power may be thus taken as $\frac{1}{10}$ h.p. exerted over 10 hours. Mr. Emerson "would not advise any man to try such a feat" again.

Communication with Lighthouses.—In the House of Commons on Tuesday, Mr. James Lowther asked the President of the Board of Trade whether, inasmuch as the recommendations unanimously endorsed by the Commissioners as a means of saving life at sea involved a very small estimated cost, the Government intended without any further delay to carry out the recommendations of the Royal Commission upon electrical communication with lighthouses and lightships made in December last. Mr. Mundella replied that the committee appointed to consider and report on the best means of carrying out the recommendations of the Royal Commission have the whole matter under consideration, and will report soon after Easter.

Graphical Statics.—At a recent meeting of the Liverpool Engineering Society, at Liverpool, Prof. H. S. Hele-Shaw read a paper on "The Graphical Method of Solving Engineering Problems." Now that modern or projective geometry, which deals not merely with plane surfaces, but with lines in space, has been directly applied, first by Culmann, and since by other writers, to the subject of graphical statics, Prof. Hele-Shaw is of opinion that there is no apparent limit to the number or variety of engineering problems which may be thus dealt with. A clearer understanding of the foundations of the subject is required, so as to bring into a more definite system the rapidly-growing number of problems and publications dealing with graphical statements and operations.

Electric Traction on Railways.—Engineers interested in the application of electric traction to railway lines who have not already seen a pamphlet by MM. Bonneau and Desroziers may like to know that the "Etude sur la Traction Electrique," by these engineers, is published at the Librarie Polytechnique, 15, rue des Saints-Pères, Paris. It contains diagrams of arrangement of motors and axles, a modification of which, as we understand, is being carried out. The application of electric traction in one form or another would seem to be a question of practical importance in France at this moment. M. Heilmann's steam-electric locomotive is, it is understood, likely to be tested soon on the State railway lines.

Electric Heat Recorder for Furnaces.—Some months ago Prof. Roberts-Austen showed at the Royal Society his electric high-temperature recording instrument. This is described and illustrated by diagrams in the new volume of the *Journal* of the Iron and Steel Institute. We should advise electrical engineers to make themselves acquainted with this ingenious instrument, which should prove exceedingly useful in metallurgical operations. A thermo-junction receives the heat from the furnace, and the variation of a galvanometer mirror is photographed automatically by the light from a lamp passing through suitable slits. The apparatus is arranged to be practical in workshop use, and six furnaces can be tested intermittently by means of contacts moved by clockwork.

Death by Electricity.—M. d'Arsonval has presented to the Société de Biologie the conclusions arrived at by experiments made partly under his instigation by M. Francis Biraud at the laboratory of M. Lacassagne, of Lyons, on death by electricity. They find that death occurs from two general causes—mechanical lesion of the vessels and nerves, and stoppage of the function of heart, lungs, etc. The first occurs generally when the victim is struck by lightning, or a high-tension static charge; the second by shocks from industrial machines. The first brings definite death in its train, the second apparent death, which may turn to actual death. Electrocution, according to the opinions of MM. d'Arsonval and Biraud, is complicated, barbarous, and not sure. Even a rabbit cannot be killed under 2,500 volts and 20 amperes alternating, and even then (to use a bull) artificial respiration will revive it. M. d'Arsonval dares the American practitioners to try artificial respiration after the operation. Autopsy, he says, is necessary to ensure death.

Dahl Alternating Motor.—Mr. Olof Dahl, of the Dahl Electric Company, 120, Liberty-street, New York, says Mr. F. H. Leonard, has produced a practical, simple, single-phase motor, and a number of them are in daily use. These motors can be made in any size from 1 h.p. upwards, are synchronous, and hence must run at uniform speed; they are self-excited, starting vigorously, with a torque about equal to their normal capacity. They have a high efficiency, the small 1-h.p. size a commercial efficiency of 75 per cent., increasing with size to over 90 per cent. There is no undue heating, and neither armature nor fields rise more than 30deg. over surrounding atmosphere at normal load. The armature is not broken out of step until 50 per cent. over load, and then is not injured, the current being choked back by self-induction. The motor is designed for putting on the ordinary alternating mains without change in the number of alternations. The machine has commutator and brushes, three-pole field, and appears well made.

Telephonic Entertainment.—On Monday evening last, Mr. P. P. Kipping, by kind permission of the National Telephone Company, gave an interesting entertainment at the lecture-hall of the Highbury-quadrant Church. Mr. Goring Thomas's new opera "The Golden Web," now being performed at the Lyric Theatre, was most successfully transmitted to the hall and distinctly heard by the audience. At intervals during the evening cornet solos and recitations were equally well transmitted from Birmingham. The latest intelligence on home and foreign affairs was received from the offices of the Central News by telephone and distributed throughout the hall by means of column printing telegraphs. Telephonic and telegraphic apparatus were fitted up in the hall and caused much amusement. In consequence of a large number of persons being unable to obtain admission, owing to a crowded audience, this entertainment will be repeated on Friday evening next.

Ozone.—Mr. J. C. Dittrich, chemist of the Ozone Company of New York, has an article on "The Action of Ozone on Bacteria" in the New York *Electrical Review* for 4th inst. He details the experiments of Ohlmüller on the effect of ozone: after 24 hours with two litres of ozonised air per minute the bacilli of pus were destroyed. Typhus, cholera, and anthrax bacilli, and anthrax spores in dilutions of distilled and sterilised water, were destroyed as follows: anthrax spores in 10 minutes, with a calculated amount of 89·9mg. of ozone; anthrax bacilli in 10 minutes, with 58mg. of ozone; typhus bacilli in two minutes, with 19·5mg.; and cholera bacilli in five minutes, with 40·3mg. of ozone. The ozone also destroyed bacilli in sewage and bad water. Ohlmüller sums up by saying that the results of his experiments established with certainty that ozone has a powerful destructive influence on bacteria if the water be not too greatly contaminated with inanimate organic matter. Now that ozone is prepared electrically in large quantities, these researches ought to have a wide effect in indicating the means to deal with cholera and other outbreaks of fever.

Brown Alternating-Current Motors.—Mr. C. E. L. Brown, writing to the New York *Electrical Engineer*, describes his new single-phase motors, and sends photographs showing a 6 h.p. and a 15 h.p. motor in actual work. The smaller one developes 6 h.p. with very high efficiency, as can be judged from the fact that the motor, though only weighing 330lb., gives this output without undue heating. It drives a line of shafting at their works, and in height is not up to the knee of a man. Mr. Brown has means of starting these motors of the simplest possible description, which are not yet ready, however, for publication. The larger machine gives 12 h.p. to 15 h.p. at 800 revolutions only. Its weight is but 1,150lb., and it drives a main shaft in the heavy machine shop. It has self-lubricating bearings, suitable for continuous running without attention. It may be run for many days together without even being looked at. In a month or two they will have these motors to the extent of over 100 h.p. actual running, ranging in size from ¼ h.p. up to over 20 h.p. This will be good news to alternate-current engineers, who will doubtless hasten to apply the Brown motors.

Experimental Coils.—The old Ruhmkorff coil is expensive, and where a town supply of alternating current is on tap, some fine effects with simple means can be obtained. Mr. R. W. Wood describes in the *Scientific American* a home-made coil for obtaining high-tension effects. A bundle of iron wires, 15in. long, 2in. diameter, forms the magnet, close wound with the primary (No. 6). The secondary is not wound the whole length, but on a double narrow spool, some 14in. diameter, slipped on the middle of the other; the two coils on this spool are wound in opposite directions, and the internal terminals joined. The whole is boiled in paraffin. Connected to a 52-volt circuit, a small arc, 2in. to 4in. long, occurs between carbon terminals. But it is with the Leyden battery that the tremendous power of the coil can be shown. From six to ten gallon jars are connected, inner coatings to arc and outer to the other terminals. The discharge now consists of a torrent of thick blue sparks, which give rise to a most deafening sound, a combination of a hiss and a roar. The discharge can be used to volatilise metals and obtain metallic spectra, and for other experimental purposes.

Electric Mining Machinery.—At the meeting of the Yorkshire College Engineering Society last week a paper was read by Mr. Ernest Scott on "Mining Machinery, Electrical Rock Drills, and Coal Cutters." Mr. Wilson Hartnell occupied the chair, and there was a large attendance. The advantages possessed by electrical transmission of power in mines over the hydraulic and compressed-air systems were first pointed out, and the manner in which the special dangers incident to it were guarded against explained. The constructional details of various forms of dynamos, motors, and safety cables were then described, this part of the paper being very profusely illustrated by lantern slides. The author was of an opinion that the use of coal-cutting machinery would much ameliorate the condition of the miner, and would reduce the risks to which his calling was liable. Rotary and percussion drills and the Van Depoele electromagnetic drill were described, and the paper was brought to a close by a review of a great many coal-cutting machines by different makers. A discussion followed, in which Messrs. Matthews, Wordsworth, Waterhouse, Fowler, and Maclaren took part. Mr. Scott having replied, a vote of thanks to him terminated the meeting.

Steam-Recording Gauge.—Electrical engineers are not content with a simple voltmeter, but generally take continuous records of the voltage from beginning to end of day. How many do the same with the steam pressure? Yet the steam is certainly an effective factor in the maintenance of electric pressure, and a permanent control would serve a good purpose. Many of the American electric stations now use the Edson recording steam-gauge, and find the control so exercised of great value. Careful firing is ensured, as the men keep their eyes on the record. Theoretically, small and frequent firing is desired and often attempted, but it requires a visual encouragement, such as the recorded movement of steam-gauge, to keep firemen up to their duties. The apparatus has an alarm for maximum and minimum; and this alarm can be electrically connected to bells in the chief engineer's room and in the office. These gauges are handsome, not too complicated, and though the price is rather high the gain in economy by steadying steam is probably well worth the expense. They are made by the inventor at 87, Liberty-street, New York, and it appears are largely used by both British and American Governments as well as a large number of electric light and tramcar stations.

Walker Engineering Laboratory.—In the *Journal* of the Iron and Steel Institute just published (Spon) Prof. H. S. Hele-Shaw describes in a short paper the University College Walker Engineering Laboratory at Liverpool. The lecture theatre will seat 250 people. The testing-room contains 100-ton Buckton single-lever testing machine, Westinghouse air-compressor, Worthington pump, and other machines, driven by 40-h.p. Robey engine. The woodworking department is driven by an 8-h.p. Fawcett gas-engine. There is an experimental engine, 150 i.h.p., triple-expansion marine type, locomotive boiler, dynamos, forges, and smelting furnaces. Upstairs is the drawing office and photographic room. Complete courses are given in civil, mechanical, and electrical engineering for three years. The total time for a regular course is 25 to 30 hours a week, from 15 to 20 hours of this being for lectures and classes, and the rest practical work. The electro-technical laboratory is under Dr. Oliver Lodge, with the appointment under him of a special lecturer, Mr. F. G. Bailey. There are each year four scholarships of £125 per annum, tenable for three years; 10 £100 exhibitions; and 20 £50 exhibitions, tenable for one year. The candidates must be under 26 years of age, must have been engaged in the workshop of a mechanical engineer for at least three years, with twelvemonths at vice and lathe, and must pass a practical and theoretical examination.

London Telephone Service.—Messrs. C. R. Haig and A. H. Hastie, writing from 65, Lincoln's-inn-fields to the editor of the *Times*, say: "We hope that you will allow us to inform the telephone users of London through the medium of your journal that, as the direct result of the pressure brought to bear upon the National Telephone Company by the Association for the Protection of Telephone Subscribers, the prices of private-house telephones in London, giving communication over the whole metropolitan area, will be almost immediately reduced from £20 a year to £10 a year, subject only to the condition that they are taken upon a five years' contract. The price of business telephones will remain as at present, but since the National Company have promised immediately to instal the twin-wire system, which will make speaking on the telephone clear and easy, the chief objection to entering upon five years' contracts for business telephones and taking the discount of £3 per annum then allowed vanishes. Had the New Telephone Company continued to have an independent existence our association had great hopes of obtaining an even better telephone service than has now been secured to users; but, on the other hand, it must be remembered that these benefits would have been seriously discounted by the fact that it would have been two or three years before the New Telephone Company would have been in full working order, while the present advantages would be secured immediately."

Electro-Harmonic Society.—A smoking concert will be held on Friday, April 7, 1893, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at 8 o'clock. Artistes: Messrs. Lester, Albert James, Arthur Thompson, and Franklin Clive; solo violin, Mr. T. E. Gatehouse; solo pianist and accompanist, Mr. Alfred E. Izard; humorous recitals, Mr. Fred. Frampton; ventriloquist, Mr. Frederic Russell; humorous sketches, Mr. George Cronin; musical directors, Mr. T. E. Gatehouse and Mr. Alfred E. Izard. A Bluthner piano will be used. Programme—Part I: Part song; pianoforte solo, "Die Jagd" (Rheinberger), Mr. Alfred Izard; songs (*a*) "To Chloe in Sickness" (Sterndale Bennett), (*b*) "Maiden Mine," Mr. Arthur Thompson; humorous recital, "What I Saw and Heard at a Country Concert" (Frampton), Mr. Fred. Frampton; song, "The Green Isle of Erin" (Roekel), Mr. Franklin Clive; violin solo, "Fantaisie sur Faust" (Alard), Mr. T. E. Gatehouse; song, "The Pilgrim of Love" (Sir H. Bishop), Mr. Albert James; humorous sketch, Mr. George Cronin. Part II: Part song; ventriloquial sketch, Mr. Frederic Russell; old ballad, "The Woodpecker" (Kelly), Mr. Arthur Thompson; humorous recital, "In Court" (Frampton), Mr. Fred. Frampton; song, "Tally Ho" (A. H. Miles), Mr. Franklin Clive; violin solo (*a*) "Ave Maria" (Gounod), (*b*) "Il Moto Perpetuo" (Paganini), Mr. T. E. Gatehouse; old Irish song, "Purty Molly" (Miss McShie), Mr. Lester; humorous sketch, Mr. George Cronin.

Economy of Water-Tube Boilers.—Engineers who are ready to devote years of energy to securing a phantom increase from a present 92 to a prospective 93 per cent. on their dynamos, may well look with some little amazement at a fuel economy of 25 per cent. on their boilers, such as was promised by a simple invention of M. Zahikian, mentioned in these columns a few weeks ago. This statement has aroused some interest both in England and, we see, also on the other side of the Atlantic. Wonder is expressed as to the means adopted, and incredulity as to the result attained. We have seen reports from the chief engineer of the Deptford station confirming his first results, which certainly seem reliable, but it is only natural that our readers would like to have further tests and results before them before pinning their faith to the new saviour of coal, however justifiable and reasonable may seem the invention. We learn that M. Zahikian has now made arrangements at 304, Vauxhall Bridge-road for manufacturing his invention, which he terms the "Volvo," and the opportunity will therefore be open for others to test the apparatus. In effect, it consists of an arrangement for making the water take a helical or rifling movement through the water-tube, and by this means the steam-raising power is greatly increased, and at the same time the life of the tubes is considerably extended by reason of more regular distribution of the water over the heating surface.

The Schiseophone.—Captain de Place, in the *Comptes Rendus* (115, p. 582), describes the schiséophone, thus abstracted in the *Journal* of the Institution: "This is a microphonic apparatus for testing metal for flaws. A sort of Crossley microphone consisting of rods of carbon is arranged on a stand; the rods form a triangle or square, and surround, but apparently do not touch, a steel rod. This rod is caused by any suitable means to keep constantly tapping on the piece of metal to be tested. The microphone is joined up in circuit with a battery, and a coil in an adjacent room. The coil is fixed at one end of a long graduated rod, and another coil is connected to a telephone and moved away along the rod till the sound in the telephone due to the induction of the fixed coil on the movable one is almost nil. Keeping the two coils in this position, the piece of metal (rail, armour-plate, etc.) is then slowly moved past the instrument by an assistant, the rod still tapping on it. Any flaw in the metal is at once detected by the sound in the telephone increasing. In testing pieces of metal of varying shape and thickness a table is drawn up, from tests on a sample known to be good, of the proper distance between the coils at which the sound should nearly vanish when the tapper is on different parts of the test-piece, and deviations from these distances when testing a similar piece denote the presence of flaws. The taps should not be more rapid than two in three seconds, and the tapper is best worked pneumatically by a ball and tube, like an instantaneous shutter."

Lighthouse Illuminants.—A parliamentary return has just been issued containing further correspondence between shipowners, Chambers of Commerce, Mr. John R. Wigham, the Commissioners of Irish Lights, the Trinity House, and the Board of Trade, on the subject of lighthouse illuminants. The questions referred to in the correspondence have reference mainly to a proposal on the part of the Irish Light Commissioners to increase the power of the light at Kinsale, and the use of Mr. Wigham's burner and lens. The Clyde Shipping Company states: "Of the two masters in our coasting steamers who know the Tory light best, one reports as follows: 'I am decidedly of opinion that a powerful light similar to that on Tory Island would be to the advantage of shipping. With regard to the light on Tory Island, I consider it superior in hazy weather to any of the electric lights in the English Channel." The other is also in favour of oil. Referring to Mr. Wigham's contention that as a lighthouse illuminant this new light is far more useful to the sailor than the electric light, Prof. Tyndall, writing to him on the 15th December, 1892, says: "With regard to the fog-illuminating power, the evidence possessed thus far appears to be all on your side. There is no doubt that your giant lens would enable you to illuminate fog to a greater extent than any other arrangement in existence." The Royal Astronomer of Ireland, in the course of a long letter, says: "I have no hesitation in saying that the light produced by his 'Intensity' burner used in conjunction with the 'Giant' lens does a great deal of credit to Mr. Wigham's ingenuity, energy, and perseverance, and without entering into the question of the value of gas relatively to electricity as a lighthouse illuminant (a question which I had no opportunity of examining), I have no doubt that it cannot fail to be of use to sailors in foggy weather, when even so powerful a light as the well-known first-order revolving lens of the Tory Island pattern must fail him."

Paddington Electric Railway.—In cross-examination on Monday, Prof. Ayrton, representing the City and Guilds of London Institute, at Kensington, where it is alleged the scientific apparatus would be injuriously affected by electrical disturbance and vibration, stated that the electric agency would go through the ground just as though air unless stopped by thick iron or steel shield. Questioned by Sir J. Kennaway, chairman of the committee, he was aware that in the earlier stages of railways apprehensions of damage were entertained and were not realised. Personally, he was in favour of electrical traction, and some of the promoters of this railway were his personal friends. He spoke in the interests of his students in endeavouring to prevent injury. Prof. Norman Lockyer stated that his work and that of his students at the Royal College of Science could certainly not be conducted if this railway is made, especially in solar physics and the use of astronomical instruments. Prof. Rücker, professor of physics in the University of London, agreed with Prof. Ayrton as to the very sensible and palpable vibration caused by the City and South London Railway. South Kensington was regarded as a national scientific centre, and there was collected probably the best collection of scientific instruments in the world. Close contiguity of the electric line as proposed would have a seriously prejudicial effect on the use of those instruments. At 200 or 300 yards distance it would be absolutely safe. It was admitted that the variations of natural and terrestrial magnetism are greater than any which would be locally caused by the proposed railway. Mr. C. Boys, assistant professor of physics at the Royal College of Science, and Mr. Airey gave evidence of similar purport. After hearing counsel on both sides, the committee declared the preamble not proved. The Bill is accordingly rejected. The promoters of the Clapham Junction and Paddington Railway Bill have applied to the Select Committee who rejected the scheme for their consent to a motion being made in the House for the recommital of the Bill to the same committee, with a view to placing before them a proposal which, it is hoped, will satisfy the opposition of the City Guilds Institute and the Royal College of Science. The proposal is that the use of electricity on the proposed railway shall be restricted within certain limits of these buildings—that is to say, that the trains when passing these institutions shall be propelled by some mechanical contrivance other than electricity.

THE ELIHU THOMSON WATT-HOUR METER.

BY G. H. BAILLIE, W. L. BAYLAY, C. H. C. WOODHOUSE, B.SC.

In continuation of the detailed description of the Elihu Thomson meter, given by Mr. M'Fadden before the Chicago Electric Club, and reprinted in the *Electrical Engineer* of March 17, 1893, it may be of interest to publish the general results of a long series of tests made by us some time ago at the Central Institution of the City and Guilds of London Institute.

The instrument, as is well known, was patented in 1882 by Profs. Ayrton and Perry, but was not persevered with by them on account of the apparent difficulty of overcoming the mechanical friction at the commutator and bearings. This difficulty has, however, been practically annihilated by Prof. Elihu Thomson. The specimen tested by us was sent as a present to Prof. Ayrton by the London agents of the Thomson-Houston Company in the early part of last year. It was wound for a P.D. of 100 volts and a maximum current of 25 amperes. We tested the accuracy of its readings with both direct and alternating currents.

Direct-Current Tests.—If a constant P.D. of 100 volts be maintained at the terminals of the meter, we find that the armature will start with a current of 0·1 ampere in the main circuit. The power supplied to the circuit to which the meter was attached was measured by accurately standardised voltmeters and ammeters. The meter was found to read accurately when run either with only one eight-candle lamp, or with a resistance taking 14 amperes at 100 volts. With 25 amperes at the same P.D. the readings of the instrument had to be multiplied by 1·005 in order to obtain the number of watt-hours supplied. The relation between the reading of the instrument and the energy supplied to the circuit was not affected by an 8 per cent. variation of P.D. between the mains.

Alternate-Current Tests.—The power supplied in this case was measured by a Ganz wattmeter, the current by a Siemens dynamometer, and the P.D. by a Cardew voltmeter, all of which instruments had been carefully calibrated previously to the experiment. If the circuit to which the motor was attached were non-inductive, the power supplied was again read off directly from the position of the index. When, however, the circuit was very inductive it was found necessary to multiply the reading of the meter by a constant, depending on the frequency, in order to obtain true watt-hours. In order to see how nearly the constant could be predicted from the formula published in 1888 by Prof. Ayrton for the correction of a wattmeter,

$$\frac{\text{Apparent watts}}{\text{True watts}} = \frac{1 + \tan\theta \,.\, \tan\phi}{1 + \tan^2\phi},$$

where θ is angle of lag between the current and P.D. in the circuit to which the power was supplied, and ϕ is the angle of lag in the armature circuit of the meter, the following measurements were made: The resistance, r, of the armature circuit = 960 ohms; the self-induction of the same, as measured by an Ayrton and Perry reversing secohmeter, = 0·055 secohm.

From these values we can find ϕ from the formula

$$\phi = \tan^{-1} \frac{Lp}{r},$$

where $p = 2\pi \times$ frequency.

Also θ, the angle of lag in the load circuit, is obtained from the formula

$$\text{True watts} = \text{volts} \times \text{amperes} \times \cos\theta.$$

The following is a summary of the results:

Frequency.	θ	Experimental constant.	Calculated constant.
100	56°	0·943	0·949
150	56°	0·910	0·910

It is evident from the close agreement between the calculated and experimental constants that the above formula for the correction of a wattmeter can be applied in this case, and hence we find that the meter, if accurate with direct currents, will read to within 0·5 per cent. at 100 periods per second, provided that the time-constant of the circuit to which the meter is attached does not exceed ·00028 secohm, a value higher than that of a load of lamps.

At the time we were making these experiments, Prof. Ayrton suggested that, if this meter were arranged to be used as a central-station meter on high-pressure mains, the error due to the relative time-constants of the meter and of the circuit to which it was attached would disappear, and further, since the meter would, in such a case, not be required to start with such a small current as 0·1 ampere, the number of turns on the armature might be reduced, and, therefore, the time-constant of the fine-wire circuit still further diminished.

The following calculation was, therefore, made by us with the object of determining the proper resistance that the armature and the coil in series with it ought to possess respectively. The new wire for the armature must, of course occupy the same space as the old, and the high resistance in series must be wound non-inductively. Now, the present resistance of the armature circuit of the meter, which is for use on 100-volt mains, is 960 ohms; hence, if we wish to have the same current as before in this circuit—namely, about one-tenth of an ampere—we must have 20 × 960 or 19,200 ohms.

But this will give a waste in heat of about 200 watts. We will, therefore, take the resistance double this—namely, 38,500 ohms—and then the waste will be reduced to about 100 watts. Suppose there are n_1 turns of wire on the armature of the original meter, and that we are going to use n_2 turns of wire on that of the station meter, then since the current will be about $\frac{1}{20}$ ampere, there will be $\frac{n_2}{20}$ ampere-turns on the armature.

A station meter is always recording something, and, therefore, it will be quite sufficient for it to start with 0·5 ampere instead of with 0·1 ampere, and hence the ampere-turns in the second case may be one-fifth that in the second; therefore we have

$$\frac{n_1}{10} = 5\,\frac{n_2}{20},$$

or,

$$\frac{n_2}{n_1} = \frac{2}{5},$$

that is to say, we need only have two-fifths of the former number of windings on the armature.

The number of conductors is inversely as the square of the diameter; hence, if d_1 be the diameter of the wire on the original armature, and d_2 the diameter of that on the station meter,

$$\frac{n_2}{n_1} = \frac{d_1}{d_2} = \frac{2}{5};$$

therefore,

$$\frac{d_2}{d_1} = \frac{5}{2}.$$

Now the resistance varies inversely as the square of the diameter. Hence, if R be the resistance of the armature of the station meter, since the original armature has a resistance of 460 ohms, we have

$$\frac{R}{460} = \frac{2}{5} \times \frac{2}{5},$$

or,

$$R = 74 \text{ ohms}.$$

Hence if we fill up the armature with wire having a resistance of 74, instead of 460, ohms, and have a non-inductive resistance of 38,330 ohms in series with it, the meter will start with 0·5 ampere, and will accurately measure the total amount of energy given to a circuit, when supplied with power up to 50,000 watts, with a loss of only 100 watts in the armature circuit, or 0·2 per cent. of the maximum load.

The self-induction of the load circuit may be very high without affecting the accuracy of the meter, for an angle of lag of 86deg. in this circuit will only introduce an error of ½ per cent.

Since the torque on the armature of the new instrument on 2,000-volt mains with 0·5 ampere in the load circuit is the same as that with 0·1 ampere on 100-volt mains, in the case of the original meter it follows that the readings of the instrument must now be multiplied by 100 to give the true watt-hours.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC.MEM.INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 202.)

FIELD-MAGNET WINDING.

Continuous-current dynamos have their field magnets wound in three distinct ways, which may be classed as follows: (*a*) series wound, (*b*) shunt wound, (*c*) compound wound. Each kind has its own particular use.

(*a*) *Series Wound.*—A machine is "series wound" when the whole current is caused to circulate through the field-magnet coils, either before it goes off into the lamp or external circuit, or afterwards, so that the magnet coils are simply interposed in the circuit as if they were part of the main conductor, and this part were coiled round the magnet limbs. Such an arrangement is shown in diagram (1) of Fig. 20; where A signifies the armature, B B¹ the positive and negative brushes, F the field-magnet coils, and *l* lamps in series in the external circuit.

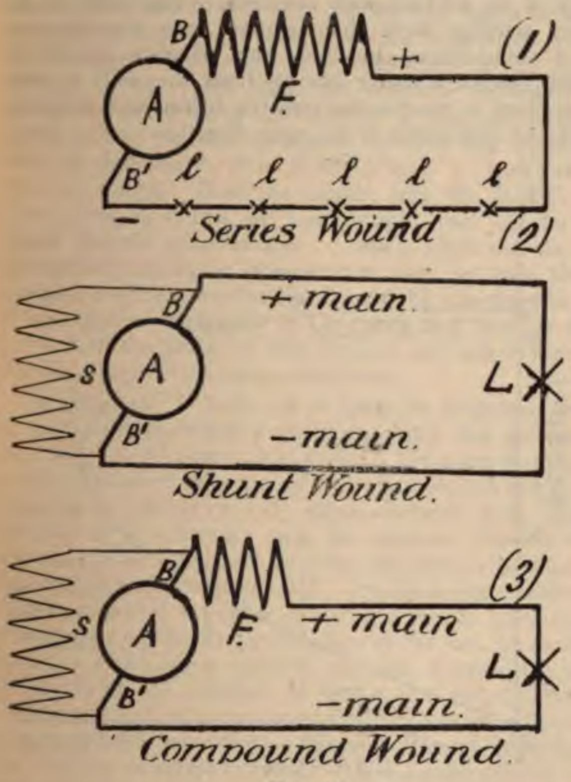

FIG. 20.

From this it is seen that, starting at the brush, the current first passes through the magnet coils, F, along the main conductor, through the several lamps, *l*, and back by brush B¹, thus completing the circuit

It is a matter not only of great interest, but one of most vital importance in studying the actions of dynamos to possess some simple means of a concrete nature to forcibly illustrate the performance of a machine by clearly exposing its action under different conditions of working, such as how the current and pressure vary; how speed effects the self-regulation; how to find the maximum output or horse-power for a certain speed, or greatest economy; how to find the maximum efficiency, etc. All these valuable things, and many more, can be obtained by plotting out curves. These curves, in short, tell us all about the machine, and, as Prof. S. P. Thompson says, "The characteristic curve stands, indeed, to the dynamo in a relation very similar to that in which the indicator diagram stands to the steam-engine. As the mechanical engineer, by looking at the indicator diagram of a steam-engine, can at once form an idea of the qualities of the engine, so the electrical engineer, by looking at the characteristic of the dynamo, can judge of the qualities and performance of the dynamo."

The most important and useful of these curves are those named "characteristic curves." Fig. 21 shows the characteristic curve of a series-wound dynamo, where the E.M.F. is plotted vertically in volts, and the current is plotted horizontally in amperes. As explained, with a series machine there is only one circuit, and therefore only one current which flows round and has the same strength at every point. The way in which the varying values are obtained is by experimental tests conducted in the following manner: The dynamo is first speeded up to a certain suitable speed, the brushes being on the commutator, and the external or lamp circuit is disconnected from the machine: the result is that the external circuit is open, and hence has infinite resistance. Under these conditions no current can flow, but we obtain a very feeble E.M.F., due to the residual magnetism in the iron; so our starting point in the curve gives us 0 for current, and almost 0 for E.M.F., as can be seen on referring to the curve O T in Fig. 21. The next step is to close the circuit, but at the same time to insert a very high resistance in the circuit. This gives us a feeble current, which, circulating round the field coils, augments the strength of the magnetic field. The effect of this is to produce an increase of E.M.F. in the armature coils. By decreasing the inserted resistance we allow more current to flow, the field becomes stronger, and consequently the E.M.F. will again rise, and so we can obtain a number of values of current and E.M.F. by gradually decreasing this resistance. We will now examine the curve and see the result of these experiments. The curve rises very rapidly at the commencement, showing that for a small increase of current, say from 0 to 7·5, we have a very great increase in E.M.F., say from 0 to 200. From here the pressure rises more slowly, so that when the current is made three times as strong, say from 7·5 to 20, we only obtain one-and-a-half times the pressure, say from 200 to 300. Beyond the last point any increase in the current gives only a very small increase of pressure. This is because the iron of the field magnets becomes saturated, and hence the magnetic field increases very slowly. When the difference of potentials at the dynamo terminals is plotted, instead of the total pressure or E.M.F. we obtain a curve, O A B C, below the curve O T, and the difference in heights between the two curves measures the loss of volts due to the resistance of the armature and field-magnet wires—this last curve is called the external characteristic, and is the more useful of the two, as it shows the available power of the machine and how it effects the lamp circuit. The curve O I represents these differences of heights, and hence the drop of volts inside the machine for various currents. The E.M.F. of a dynamo depends on the

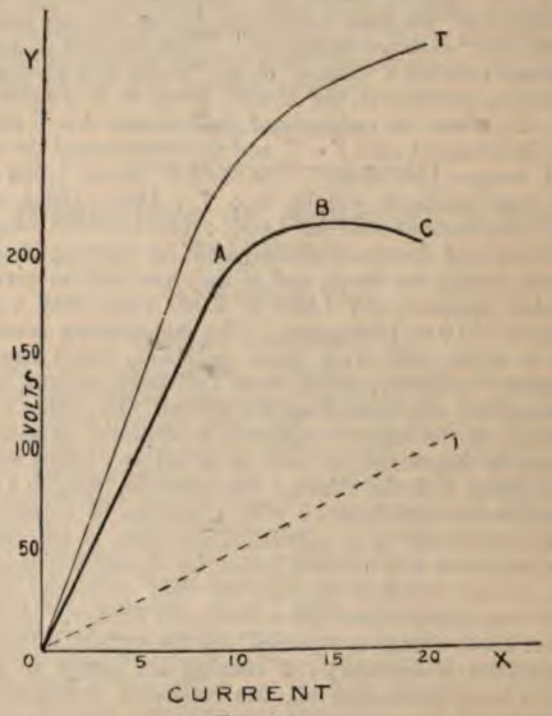

FIG. 21.

number of lines of force cut per second. It was stated that the practical unit of E.M.F. of the volt was equal to 10^8 absolute units, and since one line of force is measured by one dyne or absolute unit of force, therefore one volt will be produced when 10^8 lines of force are cut per second. The number cut is dependent on three things: first, the speed of the armature coil; second, the number of coils in the armature; third, the magnetic flux through the armature. And for two-pole machines the E.M.F. obtained can be found by the following formula:

$$E = \frac{N\,C\,n}{10^8},$$

where E signifies the number of volts of E.M.F.
" N " " magnetic flux.
" C " " number of conductors or turns on armature.
and n " " number of revolutions per second.

For multipolar machines, the number of conductors or turns on the armature must only be counted from one north pole to the next north pole.

The current given by a series dynamo is obtained by dividing the E.M.F. by the total resistance of the circuit. This total resistance comprises several resistances in series. The resistance of the armature wires and the field-magnet coils are together called the "internal resistance"; the resistance of the main conductors, lamps, etc., are together called the "external resistance." Take the case of a series dynamo running a number of arc lamps, and having the following resistances, the circuit being as in diagram (1), Fig. 20, where the resistance of the armature A = ·5 ohm, of the field-magnet coils F = ·7, and the resistance of the mains and lamps = 100 ohms. The E.M.F. being 1,000 volts the total resistance will be ·5 + ·7 + 100 = 101·2, therefore the current will be 1,000 ÷ 101·2 = 9·88 amperes. Series-wound dynamos are only used for running lamps in series, mostly arc lamps, and so they are built to give out a high pressure, say 1,000 to 2,000 volts, with a small current of 10 to 15 amperes. The lamps being connected up in series, offer very great resistance, hence the high pressure necessary, while since the same current passes through all, only a small one is required. To enable a series dynamo to run lamps a regulator is required, otherwise it would be impossible to turn on or off any lamps without interfering with the others. For example, imagine a series machine were put to work with a number of incandescent lamps connected up in parallel, if one lamp is turned out, the resistance will increase, hence the current will decrease, less current will flow through the field coils, the E.M.F. will then decrease, and the current still further. If, on the other hand, a lamp is switched on, the current is increased more than is necessary; if running arc lamps in series, and a lamp is switched off, the resistance decreases, and the current increases, which would be damaging to the rest of the lamps. Apparatus for enabling a series dynamo to run lamps will be described with arc-lighting machines.

(*b*) *Shunt Wound.*—The word "shunt," in electrical parlance, signifies usually a branch path of higher resistance than the main path—or a sort of go-by—and has probably been derived from the expression "shunting" used in railway work; and a shunt current means some fractional part of the main current. A shunt-wound dynamo means that the field-magnet coils form a shunt path to the main circuit, so that when the whole of the current leaves the brush there are two paths open to it, as seen in diagram (2), Fig. 20, one being the main conductor leading to the lamps, and the other being the coils of the magnets; the two paths unite again at the negative brush, B^1. Now, the current will divide inversely to the resistance of the two paths, as was explained previously, because these two paths are in parallel; and as only a small part of the current is required to flow round the magnets, therefore the "shunt coils," as they are called, are made of a great number of turns of thin wire, thereby offering great resistance, and so only allowing a small current to flow through. The remainder of the current, which forms nearly the whole, flows through the thick conductors to the lamp circuit. So, whereas we have a thick wire to carry the whole current for the series coils of a series machine, we have a thin wire to carry part of the current for the shunt coils of a shunt machine.

A shunt-wound dynamo is probably the best kind that can be used for running incandescent lamps in parallel by continuous currents. There is only one objection to its use, and that is, it is necessary when the lights are subject to being switched on and off, to have someone to regulate the machine by throwing resistance in and out of the shunt coils in order to keep the pressure constant. Suppose a number of lamps working in parallel were switched off, this would increase the external resistance, hence more current would flow through the shunt coils and less through the lamp circuit; but the effect of sending a greater current round the shunt coils will be to increase the pressure, and when lamps are run at a higher pressure than what they are made for they soon burn out or break. On the other hand, by switching more lamps on more current will flow through the lamp circuit and less through the shunt, and so the pressure will fall, and, as a result, the lamps will burn dull.

Diagram (2), Fig. 20, gives a view of the connections of a shunt dynamo, the letters denoting the same parts as in diagram (1).

Shunt dynamos are always used, when possible, for charging secondary batteries, and for this reason: if a series machine were used, there is the danger of having the polarity of its field magnets reversed, in the event of the batteries sending back their current into the dynamo. With a shunt-wound machine the polarity cannot be reversed because, whether flowing from the cells or from the armature, it reaches the positive brush and so passes through the shunt coils in the same direction.

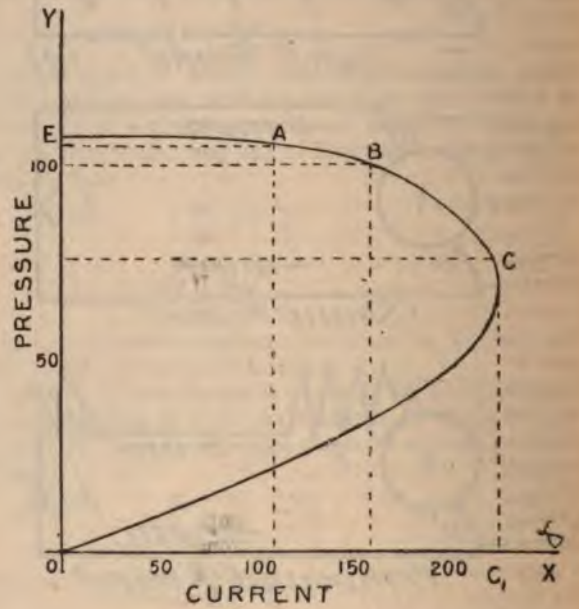

Fig. 22.

Fig. 22 shows the characteristic curve of a shunt-wound dynamo, which is very different to that of a series machine, the conditions of the two machines on open circuit and short circuit being exactly opposite. With a series machine, when the main or external circuit is open, there is no current flowing, neither is there any pressure, but with a shunt machine, when the external circuit is open, the only path left for the armature current is through the shunt coils, hence the pressure is high. Taking the other extreme, when a series dynamo is short-circuited by connecting a copper main across its terminals, then an enormous current will flow, and the pressure will also be high; but short-circuit a shunt dynamo in the same way and it will be found that the pressure drops down almost to nothing, because all the current goes into the external circuit, and none scarcely through the shunt coils, consequently the current then falls to nothing likewise. Having the external circuit open we have no current flowing in it, but a high E.M.F. at the terminals, shown by O E, and this condition gives us the first point of the curve, which is at the top. As the resistance of the external circuit is gradually lessened when closed, so more current flows through it, and consequently less current through the shunt coils, and the result of this is that the magnetic field becomes weaker and the E.M.F. falls in value. This is shown by the falling of the curve as the current increases. It will be observed that the rate of falling is very far from being constant: at the beginning it is extremely slow, but further on past B it is very rapid, until a very little increase of current in the external circuit produces an enormous fall in pressure, the fall being perpendicular, as shown at C. It may readily be imagined that this is due to the way the iron loses its magnetism, for when the magnetic field is weak the permeability of the iron is very high, and a small decrease of the magnetising current will make a great decrease in the strength of the magnetic field, and hence in the E.M.F. With the series dynamo the opposite holds there: the iron gets saturated, due to the great current that flows through its magnetising coils; and the permeability being very low, any increase of current in the external circuit, and hence in the magnetising coils, will not make the magnetic field much stronger, consequently the E.M.F. rises very slowly, and its rate of rising becomes less and less. The curves of magnetisation of iron should be studied together with the characteristic curves of series and shunt dynamos, since each will help the other. Continuing the explanation of Fig. 22: at point C the current reaches its maximum value, and if the external resistance is decreased any further, the current will begin to *decrease*, because the field has become too weak to produce a strong current even with a very low resistance in the external circuit; at the same time, the pressure continues to fall gradually, until, when the machine is short-circuited, both pressure and current disappear, so that the curve takes both a downward (for E.M.F.) and a backward (for current) course. Both the current and the E.M.F. fall at equal rates, as shown by the straight part of the curve, which travels towards zero. Much more can be learnt by carefully studying these curves step by step than by any more written explanations; and by keeping the shape of the curves constantly in the mind, they provide mental pictures of the action of the dynamo, and aid to remember the laws they illustrate so effectively.

(*c*) *Compound Wound.*—If a lamp be switched on in a parallel system, using a shunt machine, the current will increase, but the pressure will fall. If the same be done with a series machine the current will increase, but the pressure will rise. Neither will do alone, because with lamps in parallel it is necessary that the pressure should remain constant when lamps are switched off and on in order that the rest should not be effected; but since one machine produces a rise and the other produces a fall of pressure, it is possible, by a suitable combination of the two, to produce a machine which has a constant pressure irrespective of any alteration of the number of lamps that may be burning. Such a machine is a compound-wound dynamo, which gives a constant pressure, with a varying current dependent on the number of lamps burning. "Compound wound" signifies the use of both series and shunt coils on the field magnets. This method is shown in diagram (3), Fig. 20, where the fine shunt coil is denoted by *s*, and the thick series coil is denoted by F. The shunt coils consist of a large number of turns, while the series coils have only a very few.

On plotting ohms for horizontal values, expressive of the resistance of the external circuit, it will be found that the highest point of the series curve is when the resistance is lowest, and this is as it should be. The shunt curve, on the other hand, is at its lowest; following the course of the two curves, as the external resistance is increased, so the magnetising force due to the series coils diminishes, whilst that due to the shunt coils increases. Then comes a point where they cross each other. When the shunt gets near to its maximum values, and the series near to its minimum, the two curves increase and decrease respectively at a very slow rate. The ratio of the number of turns of the shunt to the series must be such that as the one increases in magnetising power the other will decrease in strict proportion, consequently the resultant effect of the two coils is to maintain a constant pressure. This condition is attained when the sum of the heights of the two curves at every point is constant, and so gives a straight resultant curve, perfectly horizontal.

A compound dynamo can only be run at some one particular speed in order to give a constant pressure under a varying load. The reason of this is not far to seek. The higher the speed of a series machine the higher the E.M.F., since E.M.F. is proportional to speed. This is when keeping the current constant. When the speed of a shunt machine is increased, and the external current kept constant by inserting resistance, then the shunt current is greatly increased, and so the E.M.F. rises much more than what it would if the shunt or magnetising current were kept constant. It is thus seen that the effect of speed is not the same on a series machine as on a shunt, therefore if a compound dynamo be run at any other speed than what it is designed for, the two sets of coils will not regulate each other as they should do.

The field magnets of alternate-current machines cannot be "excited" by using the alternating current, since the magnets would be continually magnetised and demagnetised; it is therefore necessary to employ a continuous current, and this can be done in two ways: first, by running a small continuous-current dynamo, called an "exciter," and using it simply for magnetising the field coils of the alternate-current machine; secondly, by leading, say, some coils of the armature to a "commutator" fixed on the shaft in front of the "collector"—the alternating current thus obtained from these coils being commutated into continuous currents, and are then used to excite the magnets. In the first case the exciter is run at a constant speed, and so the magnetic field of the alternate-current machine remains constant in strength; in the second case, the exciting current coming from the armature may vary in value, and so promote self-regulation.

(*To be continued.*)

THE POSSIBILITIES OF HIGH-SPEED ELECTRIC TRACTION.*

BY FRANK B. LEA.

(*Concluded from page 283.*)

In all other respects the mechanical details of electric traction offer equal advantages to those of steam locomotion, whilst in many cases they are far superior. Brakes may be operated electrically just as well as with air pressure or vacuum obtained by a steam-pump or ejector on the engine, and electric heating appliances are able to minister to the comfort of passengers quite as economically as—and certainly with more satisfaction than—a supply of live or exhaust steam from the locomotive.

There are, however, some other considerations which require dealing with before we can imagine mighty improvements, and these considerations touch largely upon the matter of cost, both in first outlay and working charges. At the outset it must be admitted that absolutely new lines would be required for high-speed electric traction after the manner proposed; the railroads at present employed for steam locomotives would obviously prove quite unsuitable, not only because of heavy gradients or sharp curves and possible danger from junctions and other crossing points, but principally by reason of the less rapid traffic, which must be accommodated in some way and which can hardly be turned off altogether, in order to keep the lines absolutely free for the lightning expresses. It is conceivable that a steam locomotive might run a train—though, perhaps, not very efficiently—at 100 miles an hour on road-beds of the ordinary English type; but such a speed could not be kept up for any distance, for the most probable reason that there would be a coal train in the way. Most of our English roads are already worked up to their fullest capacity, consistent with the due observance of a strict block system; and further traffic can only be arranged for by adding fresh lines. It is therefore just as easy and advisable to build absolutely new roads, from the engineer's point of view, for higher speeds, though such a course might increase the capital outlay very largely owing to the necessary purchases of land, and to the legal and parliamentary charges incident to obtaining a right of way. There seems, however, no better plan to suggest, unless, indeed, some of our more enterprising railway companies themselves take up the question of high speeds, and set aside part of their lines for the purpose, or else double-deck those already in use, and thereby extend upwards when the cost of land, etc., forbids a greater width of line being taken.

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* Paper read before the Owens College Engineeri
March 14, 1893.

However, this is by the way; the necessity of new roads for high speeds, being admitted, gives at once the crux of the whole question, for it is useless incurring heavy expenditure on this account unless there is a reasonable expectation of continuous traffic at remunerative rates, however well worked out the mechanical details may be. It is, of course, extremely difficult to estimate in any way the possible cost per mile of a new railroad upon which the trains are to attain a speed of 120 miles per hour. Much depends upon the locality, the popularity of the proposal, the type of permanent way adopted, etc.; and the capital outlay might be anything, from the £80,000 per mile of the Liverpool Overhead Railway up to the £225,000 per mile which the City and South London line will have cost when completed. It could hardly be less than the former amount—which falls within the average cost per mile of the Lancashire and Yorkshire lines—and it need not conceivably cost more than the Greathead line, if tunnelled the whole way. There are obvious difficulties in designing a surface railway for high speeds, and either elevated roads or continuous tunnels offer many material advantages by giving scope for easier gradients, as well as by avoiding a great many surface obstacles—such as level crossings, swing bridges, etc.

Then, again, it appears self-evident that any line for high-speed traffic must of necessity have considerable length; to begin with, it would hardly seem worth while going to great expense in order to save half an hour or an hour's time. It is when we come to the long journeys of 250 miles and over that a real saving in time is effected; and I need hardly say that, after all, the object of greater speeds is simply to save time for busy men who would otherwise spend long hours in travelling which they can ill spare. For a distance of 50 miles—as, for instance, between London and Brighton, or Manchester and Blackpool—a considerable part of the journey is occupied, to begin with, in reaching a high speed, and by the time that this has been maintained for a quarter of an hour, or 20 minutes, it must be reduced in order to stop. The variations in output at the generating station, or stations, are thereby rendered very great, and it is most difficult to come within hailing distance of the engineer's ambition—full load for 24 hours in the day. The time occupied in transit could hardly be less than 30 minutes. If an hourly service were in operation the man who just missed one train would practically spend an hour and a half in making the journey, or the same time as that which the ordinary steam locomotive requires for the trip. Yet there are very few places indeed between which an hourly service of expresses will obtain good paying loads. Manchester and Liverpool are the only cities in this country to my knowledge that are so highly favoured. It will be seen from these two facts regarding the line for high-speed traction—first, its special nature and construction; second, its length—that the amount of capital required for this purpose alone would be very considerable. Probably there would be no chance whatever of obtaining the money unless it could be shown clearly that when built the line can be worked more efficiently and economically than by steam traction, and that the far greater speed attainable would render the line so popular to travellers with whom time is money that a constant stream of high fares may be relied upon from the passenger traffic.

There are many points of detail which could be enlarged upon in connection with the line itself, or permanent way. Thus, for instance, it is a moot question not yet decided—from the very nature of things—as to whether trains of any form or shape will travel safely at 120 miles per hour upon a couple of rails. A feeling of safety would prompt one to run the train on rails within a framework of lateral or overhead guides, so that it may be steadied in every possible way. Probably this feeling is due to experience in the oscillations of a steam locomotive; but even the rotary motion of electric-motor armatures will not prevent the side play of cars upon a bad piece of road, or in flying round a curve. It might, of course, be thought that side buffers at a high speed would do more harm than good, whilst an additional rail and wheels for steadiment would add considerably to the train resistance. Actual experiment alone will decide this point. If trains can safely run on a first-class road-bed of the ordinary type at 120 miles per hour, there is no need to trouble about guides or an additional rail. It might, however, be possible to form out of the necessary conductor system (by which the supply of electric energy is laid on throughout the line, and with which the trains must make contact), some additional support for the trains that would conduce to steadier running.

Another point to be discussed is as to whether, with a double line of rails, the intervening space, or "six-foot way," would require to be considerably more than the regulation distance. The windage of two trains of a given size meeting at 120 miles each may be calculated out by our mathematical friends, and a proper value given to the horizontal component of the air-churning. It might prove large enough to warrant a greater space between the rails in order to reduce the effect. This, of course, involves an increased width of line, and therefore a greater outlay unless the line be underground.

Turning now from the permanent way to the conductor system for supplying electrical energy along the line for operating the trains, it may be said first of all that no great mechanical or electrical difficulties need be anticipated so far as concerns the picking up of large currents by means of a sliding contact. Both at Liverpool and on the City and South London line, power to the extent of at least 100 h.p. (in some cases double that amount) is conveyed from the line conductor to the motor through a sliding contact. Nor is there any serious loss of power in this transference. On the latter line the total loss in the conductor system is only 10 per cent. with an average load of one-half. The total electrical efficiency over the whole system is stated to be 62 per cent., that of the locomotives being 70 per cent.

It is obvious, so far as concerns the supply of electric energy from one central station over a considerable distance, that a very similar state of affairs prevails both in electric lighting and electric power or traction. The electric lighting stations have found that at the outset their efficiency was very low by reason of the small demand which led to the plant being idle for many hours of the day. As customers increase, so does the demand for light; and if storage is available the generating plant may be run continuously at a high efficiency.

So also is it the case with electric railways, especially those for high-speed traction. The cost of electric energy is high, therefore it can only be used for the best-paying traffic, and that means only a very partial employment. If the cost were materially reduced, the whole of the traffic would be operated by electric traction, and the generating plant thereby kept fully employed, or, conversely, if it worked all the traffic, it could be produced more cheaply. The variations in demand for current are extremely great under these conditions, ranging from zero to the maximum, and the plant must always be prepared to yield the maximum output at any time, although only occasionally called upon to do so.

The arrangement of the station, or stations, for the necessary generating plant may be according to any one of a number of systems. Thus, for instance, if alternating currents are employed, it might be possible to divide the entire line into sections of considerable length—say 100 or 200 miles—each of which would be operated from one station. In the latter would be generators, working at, say, 500 or 1,000 volts, with a step-up transformer, from which the current would pass into the line feeders at, say, 10,000 volts, thus economising very greatly on the cost of wire for the feeders. The conductor system would be divided into isolated sub-sections—say, 10 miles or less each—all of which would have separate step-down transformers, so that the feeder current at 10,000 volts would pass in to the conductor system at a pressure of 3,000 volts. There would not, I think, be any great difficulty about the electrical details, whether alternating or continuous currents be employed, and whether the generating stations be few or many. The experience gained already in the transmission of energy over long distances, and the transference of large powers through a sliding contact, ought to prove sufficient for a simple extension like that of a high-speed electric line.

One great advantage of employing electricity is, of course, that the steam-engine used to drive the dynamo-generators in the station or stations may be of the most economical type, with a coal consumption of not more than 1·75lb. per horse-power hour. The pity of it is that even this excellent result cannot be fully utilised, but that for a total of many hours the engines do no work at all, except turn themselves round, or are only called upon for a fraction of the power they can exert. The maximum power which must be available, whenever required, depends, of course, upon the number of trains on the line in any one section—that is, upon the frequency of the service; and these causes have also a considerable effect upon the number and position of the generating stations.

Taking an average high-speed train-load as, say, 40 tons, the horse-power necessary to propel this weight upon a level road at 120 miles per hour would be about 350, assuming the air resistance to be 6lb. per square foot on an area of 50 square feet, and the train resistance 20lb. per ton. Of course, with maximum grades of 2 per cent., this estimate of horse-power would require to be increased very considerably, and it would mean that in the generating station at least 600 h.p. to 700 h.p. must be available per train on the line, although this maximum might be required but seldom.

It is extremely difficult, if not impossible, to compare the actual cost of working with that of a steam railroad. Not only is the expenditure of fuel calculated for the latter, as a rule, on the "train mile" or "engine mile," whatever that may mean, but no mention is made of the "passenger mile, which, after all, forms the true test. If calculations are made on the latter basis, it will obviously be to the advantage of the line with the lightest rolling-stock, the least dead-weight carried per passenger, which is as it should be, for there is no sense in running a steam train of 300 tons to carry 250 passengers when the far less dead-weight of an electric train serves for as many passengers on a total weight of about 100 tons.

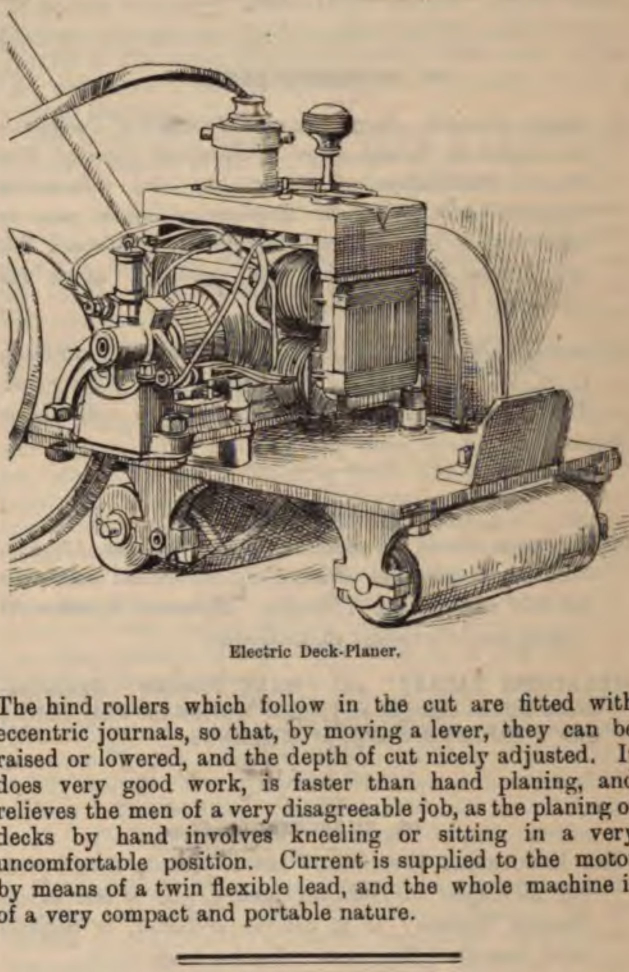
In conclusion, what are the results to which we have been led? The problem we set out to discuss was twofold: first, has electricity as a tractive agent superior advantages in a mechanical sense compared with the most improved use of steam for high-speed traction; and, second, is high-speed electric traction capable of development on a sound commercial basis—that is, in common language, can it be made to pay? The first question may be answered, I think, with a decided "yes," the second with a very qualified affirmative. It is only under especial conditions, where there is much intercourse between places at a great distance—*i.e.*, at least 250 miles apart, and where natural obstacles do not entail too great an expense—that a line of this kind will at the outset yield sufficient to repay the necessary first cost. As time goes on, however, the increase of communication would act and react until even short lines of, say, 50 miles or so, might prove very profitable, especially if by reason of still greater efficiency in the mode of generating electric energy, its cost could be reduced to a fraction of its present amount. As soon as goods trains and heavy traffic in general can be worked as cheaply by means of electric traction as now is done by steam locomotives, there can be no doubt that the former system will come into universal employment. At present, however, electric energy cannot be obtained cheaply unless it be used continuously, unless the station is at full load all day long, a contingency not likely to happen until the whole of the traffic, goods and passenger, is worked by it. The result is somewhat of a deadlock, but there is no doubt that the matter will right itself in time, as already pointed out.

This paper is not intended in any way to specify many details: it has been written rather for the purpose of suggesting thought by pointing out what may or may not reasonably be expected in the early future, judging from what is to be learnt from the past and present. It is with this in view that criticisms and suggestions are more especially invited.

A NEW ELECTRIC TOOL.

The use of electricity for transmitting power has been steadily increasing during the last few years. Not only is it often found better than mechanical transmission, but in many cases it enables mechanical power to be applied to work where, without electricity, it would be quite impracticable to use anything but hand power. One of the latest machines of the latter kind is an electric deck-planer, invented and patented by Mr. Malcolm Sutherland, electrical engineer to Messrs. Wm. Denny and Bros., the well-known shipbuilders of Dumbarton.

Our illustration shows one made by that firm, and used by them for planing the decks of the ships they build. It is so simple in construction that very little explanation is necessary. It resembles a lawn-mower in form, and is handled in the same way and with as much ease. A steel base-plate is mounted on rollers, and on the underside of this the revolving cutter is fixed. The electric motor is placed on top, and is geared to the cutter by means of toothed wheels. The latter is one of Rawlin's spiral cutters, and revolves at a speed of 3,000 revolutions per minute, the motor having a speed of 2,000 per minute.



Electric Deck-Planer.

The hind rollers which follow in the cut are fitted with eccentric journals, so that, by moving a lever, they can be raised or lowered, and the depth of cut nicely adjusted. It does very good work, is faster than hand planing, and relieves the men of a very disagreeable job, as the planing of decks by hand involves kneeling or sitting in a very uncomfortable position. Current is supplied to the motor by means of a twin flexible lead, and the whole machine is of a very compact and portable nature.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 23

Mr. W. H. Preece, F.R.S., President, in the chair.

The following is the list of members balloted for and elected:

Member.—Edwin J. Reid, 12, Wharf-road, London, N.

Associates.—Herbert John Coates, 11, Nelson-street, Broughton, Manchester; William Durtnall, Cannon-street Hotel, London, E.C.

Students.—John Hayton Carrick, Faraday House, Charing Cross-road, W.C; P. J. C. Day, 55, Longridge-road, Earl's Court, S.W.; Robt. Loraine Gamlen, 16, Clifton-place, Brighton; Alfred McDonough, 12, Goldsmith-road, Acton, W.; F. Wood Smith, 11, Earl's Court-square, S.W.; H. G. Soloman, 105, Shirland-gardens, St. Peter's Park, W.; John Outhwaite Spence, Frankfort House, Birkbeck-avenue, Acton, W.

The papers read and the discussion thereon will be given next issue.

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SCOTCHED OR KILLED—WHICH ?

The promoters of the Clapham Junction and Paddington Electric Railway have failed to prove the preamble of their Bill. This means that for a year at least the scheme cannot obtain the sanction of Parliament, and without that sanction it cannot be carried out. Before referring to the causes which have led to the rejection of the Bill, we may safely assert that if the promoters are generally supported by the inhabitants of Greater London who would ultimately patronise the line, the matter is only postponed, and the end is not yet; if, however, the convenience is not really wanted, we may have heard almost the last of the scheme. It may be remembered that that gigantic undertaking the Manchester Ship Canal was opposed tooth and nail, with the result of postponing the commencement of the work, and bringing up the initial cost of promotion to something between sixty and a hundred thousand pounds. The Manchester folk meant to have the canal, and, opposition notwithstanding, the canal is now approaching completion. Larger and smaller railways than the Clapham-Paddington have been opposed, delayed, allowed, built, and succeeded; so that the promoters, if they are catering for a real want, need have little fear but that time will bring its revenge, although they may well deplore the money unnecessarily spent and the time wasted. The opposition that has scotched or killed the Bill is practically that of the scientific staff at South Kensington. The Royal College of Science and the Central Institution are largely devoted to scientific teaching. Each possesses delicate instruments, able professors; and these learned men naturally desire as little interference as possible in their endeavours to make South Kensington the scientific hub of the universe. Unfortunately, in so many directions we have been compelled to argue against scholasticism, that there is a curious opinion prevalent that we are ever too ready to break a lance with the professors; and if we mildly suggest that in this case they may be in the wrong—why, it will be put down to prejudice! In the first place, however, let us suggest that South Kensington is not the only place, and to many of us is not the best place, to spend public money upon delicate investigations. It may be a convenient place for professors and for students, but other places as convenient might be found, with fewer objectionable features. There is this aspect of the case, that very large sums of public money have already been expended, and the institutions named are in full working order. Removal would therefore be a costly process, and ought not to be borne by the public unless the line is absolutely required for the exigencies of traffic. The arguments of the professors, although strong enough for the moment, are really not very strong. Thus, Prof. Norman Lockyer said that "London was the poorest city in the world in respect of scientific instruction, and a great many industries were going down because the scientific competition of the Continent was too strong for them." We give a point-blank denial to the conclusions to be derived from this statement. It does not matter whether the chemical, astronomical, electrical, or engineering knowledge is obtained within the walls of South Kensington or whether at Cooper's Hill, Edinburgh, or Bristol, so long as it is obtained; and it matters very little to the men who obtain the knowledge—from a monetary point of view. The industries of England will not sink because South Kensington is rased to the ground, nor swim because it continues to exist. The principal arguments are that South Kensington exists, is convenient, and the proposed new line would interfere with its more delicate work. A divergence of the proposed line would interfere less with this work, and is not too much to ask, in the face of the large expenditure that must be incurred, to remove the educational centres. In renewing their application, then, the company should consider both the proof that the line is required, and the possibility of so diverting it as to get rid of the objections from South Kensington. We have not dealt with the question of electrical measurements, solely because the greater part of these experiments relating to practical engineering could be carried out with the line in full operation. The eminent professors who control these institutions are expected to do something more than merely provide pabulum for students; they are expected to undertake original researches, and to push our knowledge in certain directions far beyond anything that can at once be saddled and harnessed by the engineer. It is this class of researches that requires quietude and safety from interferences of magnetic fields, or vibrations from earth-trembling. It is in this direction, then, that South Kensington has to be safeguarded; and it will be only by proving the imperative necessity of the line, and the impossibility of placing it further away, that will induce the Legislature to look favourably upon the project.

After writing the foregoing, we are given to understand that an attempt will be made to meet the objections of South Kensington, and to get the Bill recommitted. The promoters will, it is said, meet the opposition by providing some means of traction other than electrical to haul the trains within a to-be-determined distance of South Kensington. We do not believe this suggestion to be feasible, nor, we imagine, will the scientific opposition acknowledge it to be satisfactory. It would simply mean this: When sanction was given to the construction of the line, the line, it may be assumed, would be built. No sooner was work commenced than it would be found that two systems of haulage upon the same line would be impracticable, and every effort would be made to obtain consent to "try" the electric traction. It might not be so injurious as was supposed. Iron shielding would be used, if necessary an iron room built in which to carry out delicate tests; and owing to the pressure from shareholders and public, it is certain that once built no opposition would prevent the introduction of the required traction. Fight the case fairly and squarely upon its merits, and not get it through upon side issues. As we have previously said, it is only a comparatively small part of the work at South Kensington that would be affected; hence the whole matter lies in a nutshell: Which is the more important to the nation, the scientific research or the development of suburban railways with electric traction?

THE SALEVE MOUNTAIN ELECTRIC RAILWAY.

From the Salève can be seen one of the grandest panoramas of the Alps and Mont Blanc, and as there is no other town of the importance of Geneva so close to a mountain so admirably situated, this view is highly appreciated by inhabitants and tourists, although those who care themselves to climb 4,000ft. are necessarily restricted in number. The mountain railway which now makes the Salève one of its stations therefore presents many advantages by being able, in a delightful run of two hours, to raise visitors above the fog into the pure air of the mountains.

The track of the Salève railway comprises two lines: the first starts from Etembrières and goes to Haut-Mornex by gradients of not over 16 per cent. Thence the gradients become greater, reaching 20 per cent. up to the point of forking at Monnetier-Mairie. The track then rises by gradients of as much as 25 per cent. at a maximum, curving round the Grand Salève in a long sweep. At the curves the normal minimum radius is 50 metres (160ft.), but in one case it is reduced to 35 metres (115ft.). The section Veyrier to Monnetier has two tunnels (360ft. and 160ft.). The architecture of the stations is of simple masonry without pretence.

The power for working the railway is obtained from hydraulic station at Arthaz, situated on the right bank of the Arve. A fall of 20 cubic metres per second down 3ft. gives an available power about 600 h.p. Messrs. Rieter and Co., of Winterthur, designed the hydraulic installation, in which there are three turbines of 250 h.p. each: the first for the week-day service, the second for Sundays and fête-days in addition, and the third is spare, or for supply of other electric power in the neighbourhood. A small 25-h.p. turbine drives the exciters of the dynamos.

The generating dynamos are of the Thury type, but of a special design for direct driving from the turbines without belt or gear. The turbines only running at 45 revolutions per minute, it was difficult to erect dynamos capable of supplying 250 h.p. at such a slow speed; the plan adopted has been to employ dynamos of a normal output of 1,000 h.p. when running at a normal speed of 180 revolutions, and run these at the lower speed. It will be seen, therefore, that very powerful machines are used, working at a quarter of their force—perhaps neither a very economical nor cheap method, but one which may be, at any rate, considered solid and secure.

Each dynamo is capable of supplying 275 amperes at 600 volts. The size is tremendous—10ft. exterior diameter, armature 7ft. 9in. diameter, weight 19 tons. The axle of the dynamo is vertical, carried directly by the axle of the turbine. The field magnets are carried on a special framework. The dynamos are among the largest continuous-current dynamos yet constructed.

The speed of turbines and dynamos is constant, and the variation of E.M.F. required in the utilisation of the current is obtained by a special regulating arrangement. The exciting current for the dynamos is taken, as already mentioned, from a small 25-h.p. turbine and dynamo. This turbine is furnished with regulator maintaining a constant speed; the exciting current of this dynamo is varied by the introduction of resistances in its field-magnet circuit. A special apparatus, controlled by current brought by two wires from the end of the line, enables these variations to be brought about automatically. The E.M.F. of the exciter being thus varied, that of the generators will also be varied in the desired ratio, so that the cars in movement are always supplied with their full current.

The current is transmitted from the generating station to the central railway station at Monnetier-Mairie, distant about two kilometres.

The conductors are overhead, carried on large telegraph posts. They consist of two large copper cab
conductivity, 430 millimetres section ea
Beside the cables are also th

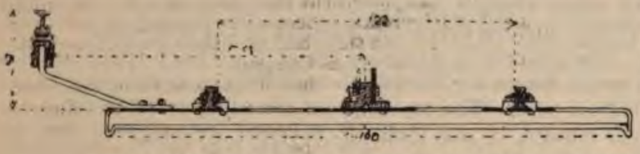
wires above mentioned. From this station the current is distributed in three sections. Along the line the conductors are formed by a Vignole rail placed parallel to the railway lines on iron brackets bolted to the sleepers, carrying strong porcelain bell insulators. On this rail is placed the shoe, with an expanding joint of soldered copper. On the shoe a slider fixed to the car receives the current. The conductor rail being the same as that of the track can be interchanged after wearing away. The return is by the railway line. The loss in the conductors is 15 per cent.

The cars have transverse compartments, they carry 40 passengers, 24 in the three compartments, and 16 on the two platforms (continental tramways generally allow riding on the platforms). The car, complete, weighs 12 tons.

The traction is carried out by double set of motors and cogwheels gearing into a cogged rack. Safety is thus assured, as either set is capable of holding and starting a loaded car on the maximum gradient. The motors are four-pole Thury dynamos of 25-kilowatt capacity (30 h.p.), running at 600 revolutions. This speed is capable of being varied within considerable limits, the speed of progression varying from 1·5 metres to 2·85 metres (5ft. to 9·5ft.) per second. The driving switches can be worked from either platform.

Eight brakes are fitted to each car: four friction brakes, two electric brakes, and two absolute stops. The electric brakes are formed by the motors themselves, which during descent act as dynamos. The current thus generated is absorbed in resistances placed beneath the cars. Lastly, two racket pawls prevent the car running back if by accident the current is accidentally stopped.

The whole of this powerful mechanism is placed beneath the car between the axles, so that the car itself, whose sides and ends are glazed, presents an open and elegant appearance. Each car has three axles, the middle one carrying wheels without springs. Each of the others has one fast and one loose wheel to facilitate turning the curves.



Section of Rail.

The rackwork track is on the Abt system, composed of one or two toothed steel plates placed on the sleepers down the centre of the track. Gradients of more than 12 per cent. have two toothed racks. The whole track is metallic, the rails are of steel (15·3 kg. per metre), and steel sleepers are also used.

The junction points are rather complicated, as it is necessary that the wheels should clear the rackwork. M. Abt has designed points which solve the difficulty with as great simplicity and solidity as possible.

The line is divided into three sections of about three kilometres each. About 250 h.p. are used in ordinary working. The maximum speed of running is six miles an hour, and on gradients of 25 per cent. about three miles an hour. The line ends at the station of Arbres, 3,800ft. above the sea. Cars run every half-hour in the season. The electric part of the installation was carried out by the Compagnie de l'Industrie Electrique of Geneva.

COMPANIES' MEETINGS.

WOODHOUSE AND RAWSON UNITED, LIMITED.

An extraordinary general meeting was held on Monday at the Cannon-street Hotel, E.C., to consider and, if thought fit, to pass a resolution for the winding-up of the Company, and to appoint a liquidator. In the absence of Sir Rawson Rawson, through a family bereavement, **Mr. S. Pope, Q.C.**, occupied the chair. He mentioned that Sir Rawson Rawson had recently lost a daughter, and in his state of health, that had had a great effect upon him; he had requested the speaker to preside on that occasion.

The Secretary then read the notice convening the meeting, and which stated that it was called "for the purpose of considering and, if thought fit, of passing, as an extraordinary resolution, the following resolution—that is to say: 'That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the Company be wound up voluntarily, and that there be conferred on the liquidator or liquidators all the powers which, by virtue of the Companies Acts, 1862 to 1890, can be conferred on liquidators.' Should the resolution be passed, a further resolution will be proposed at the same meeting for the appointment of a liquidator or liquidators for the purposes of such winding-up. Should these resolutions be passed, the Directors propose to submit to the meeting, at all events for preliminary discussion, the scheme for the future reconstruction of the Company."

The **Chairman** thought that his duty in the chair would be to put them exactly as he could in possession of the facts regarding the present position of the Company. As soon as they met together to receive the report of the committee appointed at the annual general meeting, a receiver had, at the instance of a debenture and share holder and a creditor, been put into possession of the assets of the Company as receiver and manager. The Directors did not see their way to resist that appointment, nor did the trustees for the debenture-holders. In fact, Sir Rawson Rawson and himself, as representing the debenture stockholders, felt that it was necessary that if a receiver was appointed at all, he should represent the whole of the interests of the Company, and therefore the receiver and manager was now in possession of the assets of Company representing the debenture-holders, the debenture stockholders, and also the interests of the shareholders. The receiver had, by authority of the Court, as he (the speaker) understood, been enabled to raise a small sum of money for the purpose of carrying on the business of the Company to a small extent in order that it might not altogether subside. In addition to the receiver, who was now in the office with the sanction of the Court, there were upon the file of the Court two further petitions praying for the appointment of a liquidator under a compulsory winding-up, and therefore, as those petitions had stood over, and would not be heard until April 11, the Directors had thought it important that the shareholders should meet to discuss the position in order that they might decide whether in the interests of all parties it was desirable that the concern should be broken up, or that an effort should be made to keep it together, in the hope that something might be done to minimise the loss to all concerned. He did not desire to make any comments then upon those petitions, but he ventured to say that it appeared to him that eagerness to break up the concern was not proportionate to the smallness of the stakes of the individual petitioners. The first petition was on the part of a debenture stockholder for £250, and it did appear to the Directors, certainly to the speaker, very desirable that those who had a larger stake in the concern should have an opportunity of deciding what was the best way of dealing with it than those who were very little interested. They would remember that the report of the committee, about which he did not intend to say a word in the way of discussion, pointed out that if the assets of the Company were realised in an intelligent manner there would probably be sufficient to pay the liabilities of the Company. It also indicated that the debenture-holders could be paid off, and therefore they would see that the interest of a debenture-holder in winding up was not like the interest of a shareholder, who, if the concern was entirely broken up and the assets realised at broken-up prices, had not much chance of getting anything back. The question, therefore, really was for the shareholders to determine whether something should be done by reconstruction or some other way to save some of the assets of the Company for the benefit of the shareholders. That was, as it seemed to him, really the question which the shareholders had to decide. They would observe that the Directors had called them together with the formalities which were necessary to make the resolution a binding resolution of the Company, and not a mere gathering of those who could not pass any resolution, but something which might be effective in its way. As far as the Directors were concerned, and as far as he was concerned, if the shareholders saw their way under new management to reconstruct the Company they would do all they could to facilitate and to assist in such reconstruction. Speaking for himself, he thought it was essential in any reconstruction that those who found the sinews for the purpose of that reconstruction should have the nomination of those who were to have the administration of the affairs of the Company. He thought he expressed the unanimous opinion of all his colleagues that in the event of the shareholders desiring such reconstruction, the seats of the existing Board would be placed at their disposal, and they would be asked to find a new board of administration. They were also strongly of opinion that no scheme of reconstruction could be likely to be acceptable to the shareholders excepting upon these conditions. It seemed to them exactly as it appeared to the committee who met them on the last occasion, that it would be idle to expect shareholders or anybody else to put more money into the concern if the profits of that concern were to be swallowed up even in the payment of old liabilities or in the payment of the burden of the debentures. The Directors therefore thought that if any scheme of reconstruction was possible, the first thing to ascertain was that there was a good background of business worth preserving. As far as he knew, the facts with regard to that were these: they must satisfy themselves other than by his word. They would remember that the report of the committee estimated roughly—of, course, being unable to go into any amount of detail—that the industrial part of the business might command about £11,000 a year profit, that being only about sufficient to pay the debenture interest, and therefore leaving nothing to be divided among the shareholders. The general manager, however, took a more sanguine view. Judging from the business which he had been compelled to refuse since the general meeting in December, he put the profits at very nearly three times that amount. Of course, he (the speaker) was only telling them that that was his (the general manager's) sanguine expectation; but the receiver, he believed, had also formed his judgment of the possibilities of the business during the experience he had had in the meantime. The speaker had been told that the receiver would, if asked, express the opinion he had formed, although he had not any information as to what that opinion really was. It did, however, seem to the Directors perfectly plain, whether the income was £11,000 or £30,000, or anything between the two, that the first people who ought to have a claim upon those profits were those who found the money for carrying on the business. The second condition appeared to be that the money found should not go in payment of the old debts, which should be left chargeable upon the assets of the Company as they were now, without an additional charge, and, further, that in any reconstruction the shareholders ought to require an entirely new management of the industrial part of the concern. The question was whether they, as shareholders, thought it would be better to break up the concern, which of course meant the immediate realisation of the assets, which required time to develop to obtain their full value, or that an attempt should be made in order to see whether a reconstruction could save something in the interests of the shareholders, who otherwise would get nothing. If that was their view, the resolution contained in the circular convening the meeting would be the resolution which they would pass. In order, if they wished it, that they might know more of what had been done by the Directors in the way of endeavouring to bring about such a scheme of reconstruction, he would ask Mr. Carslake (the solicitor) to give them a sketch of such a scheme. The resolution would be to appoint a liquidator to apparently wind up, but with a view to realise the assets gradually, and at such a price as to leave something out of the wreck for those who were interested. He supposed that the best course would be for him to move the resolution.

Mr. Carslake, the solicitor, had not much to add to what Mr. Pope had already said with regard to the scheme for reconstruction. It was as yet only an outline of the details: all the particulars would require further consideration. Broadly speaking, the suggested scheme was as follows: That a new company should be formed which would take over the assets of the existing company, but it would take them over in such a way that whilst the charges of the debenture-holders and debenture stockholders on those assets would remain as now, the new company would not incur any personal liability to the debenture-holders or debenture stockholders, but the new company would take those assets and really use them and realise them, paying the proceeds to the receiver or liquidator of the existing company, who would distribute them among the debenture-holders and debenture stockholders, and the new company would get a certain profit on the turning over of the assets and realising them. By that means the existing company would have whatever capital was put into it intact and unaffected by the existing company in any way. The ordinary creditors of the existing company would, of course, have to be dealt with in some way, and the proposal was that they should be offered preference shares in the new company, and if they did not accept these preference shares that they should retain their present position. With regard to the bringing in of capital for the new company, and dealing with the shareholders of the existing company, there were two schemes, concerning which the Directors had not quite decided which was the best. One was that the working capital should be provided by the issue of shares which would be paid for in full by the shareholders, and that the shareholders should receive some sort of security—income bonds, or something of that nature—which, whilst imposing no further liability on them, would give them the right to the surplus profits of the new company, or that something in the nature of income bonds with, say, 90 per cent. credited as paid up and the remaining 10 per cent. to be called as working capital, should be given to the shareholders of the existing company, who might then possibly be given a small nominal share in the new company, carrying with it voting power, so that they would retain their control in the new company. The shares or income bonds would have to be offered first to the preference shareholders of the existing Company, and then those which were not taken up by the preference shareholders would be offered to the ordinary shareholders to be taken up by them. That was necessary, because, of course, the preference shareholders had a first claim upon the assets of the existing company, both as to capital and dividend. He did not think for the moment he could go into further details, because the scheme was now before counsel for consideration; it required great thought and care to work out a thoroughly good scheme, and the time which had been at disposal had hitherto been rather short.

Mr. Swain, before they committed themselves to any scheme, wanted to know what was the amount of the debenture debt, who held the debentures, whether they were members of the late company, and whether in allowing the present Directors to clear out and form a new company they were not putting money into the pockets of the Directors. He would like to learn to what extent each individual director was concerned.

The **Chairman** observed that the amount of the claim which the debenture-holders had upon the Company was £142,000.

Dr. Duncan, who held 100 preference and 200 ordinary shares, remarked that he had taken them up on the faith of the prospectus sent to him in November, 1891. He quoted from a paragraph in the prospectus, and which mentioned the steady and progressive increase in the Company's business, and then made quotations from the report of the committee of investigation and the reply of the Directors. He demanded the name of the counsel who advised in the case of the Kensington stores. (The **Solicitor**: It was Mr. Kenyon Parker.) Continuing, the speaker observed that in face of the discoveries made it was manifest that the statements made in the prospectus were absolutely false, and that it was quite untrue for the Directors to allege that they were justified in making those statements. Two at least of the Directors and Sir Edward Thornton knew very well the meaning of the words. Now they might imagine that at the very time the Directors were borrowing money at enormous rates of interest—from 10 to 22 per cent in order to pay dividends of 15 per cent.—they had the audacity to go and ask the Company to subscribe for ordinary shares and pay a premium of 5s. per share. He had not received one penny as dividend, nor was he likely to do, and he felt that he had been defrauded of £1,500. He urged the shareholders not to agree to voluntary liquidation, but to have a judicial winding-up so that the transactions of the Company might be investigated in the Court. Not only that, but that the conduct of the Directors could be investigated thoroughly in the Bankruptcy Court. In addition to that, he asked all shareholders who had subscribed for shares according to the new prospectus in November, 1891, to support him in his determination to bring an action against the Directors for the false statements made in the prospectus. The only other remark he had to make was to formally propose, as an amendment, that the Company which was rotten to the core should be compulsorily liquidated, and that the whole affairs should be investigated in the proper manner.

Mr. W. S. Squire (chairman of the committee of investigation) said that before the shareholders voted on that amendment, he would like to read some notes he had prepared. He then proceeded to defend the report of the committee against the effort of the Board to minimise its importance by the printed remarks made on the report circulated with the notice convening the meeting. He said that the report was not a full one. Although his opening remarks were given, Mr. Pope's speech, in which he admitted the substantial accuracy of the statements, was suppressed. Among other things, the Board denied that the managing director had received any part of his commission in cash. The facts were that in June, 1890, the managing director owed the Company £3,607; on June 30, 1890, he was credited with £13,775, which then made a balance in his favour of £10,167. Between then and September 30, 1890, he received from the Company in cash £34,600, whilst his account was not credited with anything till December 31, 1890, when he appeared to have paid the Company £189, which was the only item to his credit for that half-year. Consequently, the managing director not only received the £10,167 in cash, but also a great deal more. The speaker then dealt with other items, and observed that however the Directors might quibble about each item, the solid fact remained that they had induced the shareholders to believe for two years that the Company was doing well, and making substantial profits, whereas at the end of the third year they had to confess that they had muddled away all the ordinary and preference capital of the Company.

Mr. Abrahams was of opinion that if the matter of the Kensington stores had been properly placed before Mr. Kenyon Parker, the latter would not have passed the opinion which he had. He considered from the prospectus that the Directors were not justified in embarking in the patent-agency business, or in the formation of half-a-dozen companies. He was glad to learn that proceedings were likely to be taken; after the revelations it would be a public scandal if the Directors were permitted to go free. The Directors were liable, and he was sorry that Mr. Pope had become associated with the Rawson family. He was inclined to vote for voluntary liquidation.

The **Chairman** then put to the meeting the resolution given above, and which was seconded by **Sir John Stokes**.

Mr. Bond, a barrister, was of opinion that by consenting to voluntary liquidation the shareholders would not impugn their right of action against the Directors, but rather that it would facilitate matters. It was, moreover, always possible to turn a voluntary liquidation into a compulsory liquidation. With regard to the opinion of the receiver, it would be desirable to hear that.

Mr. Maddison, representative of the receiver (Mr. Leslie), stated that the receiver had formed the opinion that there was considerable backbone to their business. The receiver had told him that he was surprised at the amount of work in hand, which, as far as he could judge, was being done at remunerative prices. Acting as receiver for the debenture-holders, it did not interest them whether the shareholders got any assets at all. At the same time his principal client was both a debenture and a share holder, and he wished to have some return on his debentures and shares. He said that if they went into compulsory liquidation the shareholders would not receive anything

Mr. Bacon (one of the committee), in the course of his remarks, suggested the appointment of Mr. T. Pilling, who was a qualified man, as the liquidator. That gentleman had been of great assistance on the committee in ascertaining the position of the Company.

Colonel Poe remarked that, like many others, he had been induced to buy shares on the strength of the names of the Directors. He did not think the Directors were justified in inviting subscriptions to shares at 5s. premium when the shares were selling at 10s. discount. He supposed that voluntary liquidation was the best.

Mr. Pilling and others having made some observations.

The **Chairman** put the amendment in favour of compulsory liquidation. This was lost by a large majority. He then put the resolution for voluntary liquidation, and this was carried without any dissentients.

Mr. Bacon proposed and **Mr. Squire** seconded that Mr. T. Pilling, a Manchester accountant, should be appointed liquidator.

Mr. Waine proposed and **Mr. Morrison** seconded, as an am ment, that Mr. Young, of Messrs. Turquand, Young, Weise, Bishop, Clarke, and Co., should be the liquidator.

The motion, being put to the meeting, was carried on a show of hands, the amendment being rejected.

A poll was then demanded and taken, and on various shareholders objecting to many proxies in favour of Mr. Young as being invalid, owing to its being impossible to identify the time and date of their receipt, the Chairman drew up the following declaration: "I, Samuel Pope, Q.C., chairman at the extraordinary general meeting of Woodhouse and Rawson United, Limited, held at the Cannon-street Hotel on the 20th March, 1893, declare that on the poll taken on the appointment of a liquidator, the votes of members personally present and voting in favour of Mr. Young are 5,090, and the votes of members personally present in favour of Mr. Pilling are 6,922. There are also proxies representing 31,476 votes, of which 788 votes were used in favour of Mr. Pilling, and 30,688 in favour of Mr. Young. These proxies have all been objected to on the ground that some were lodged at the Company's office less than 48 hours before the time fixed for the meeting, and that these were mixed with the rest of the proxies and could not be distinguished. As I have received evidence which satisfies me that proxies were received by the Company more than 48 hours before the time fixed for the meeting, amounting to 5,139 votes used in favour of Mr. Young, I admit them accordingly; and the like evidence having satisfied me that proxies were received at the offices of the Company more than 48 hours before the time fixed for the meeting, amounting to 788 votes used in favour of Mr. Pilling. I admit them likewise, being all the proxies that were lodged in favour of Mr. Pilling. These admitted proxies, added to the votes of those present, make in favour of Mr. Young 10 229, and in favour of Mr. Pilling 7,710. I therefore declare Mr. Young duly elected voluntary liquidator, recording at the same time that Mr. Squire, the scrutineer on behalf of Mr. Pilling, objected to my admitting the before-mentioned proxies in favour of Mr. Young."

This concluded the business of the meeting, and another gathering will doubtless be held to further consider the scheme for reconstruction.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

The fourteenth ordinary general meeting was held on Friday last at the Cannon-street Hotel, E.C., under the presidency of Mr. Sydney Gedge (chairman). The notice convening the assembly having been read by Mr. White, and the report having been taken as read,

The **Chairman**, in moving the adoption of the report, observed that the shareholders would have already noticed one difference in what had taken place between this and last year—namely, that the notice calling the meeting was not read by Mr. Sutton, but by Mr. White. The Directors thought that Mr. Sutton's valuable services should receive the recognition they deserved by his being elected to a seat on the Board—under the articles that could be done. Mr. Sutton had taken the office of managing director on the same terms in all respects to those on which he had held the position of secretary and manager, with the exception that whilst he was answerable for Mr. White's duties, he would not perform them. He was sure that the shareholders would give him a hearty welcome as a director of the Company. Now, they were like the happy nation which had not much history. They were doing well and prosperously, and there was not very much for him to say. In fact, he did not think that he could do more than mention one or two things referred to in the report. The shareholders would remember that less than two years ago the Directors borrowed £30,000 on B debentures for the purpose of discharging their floating debt, and the arrangement made was that after payment of 5 per cent. to the ordinary shareholders any surplus profits should be applied in the reduction of the debentures. The Directors had already paid off within two years £18,000 of the £30,000, and if they had done that there was a fair prospect of their clearing off the remaining £12,000 in another two years. Then the ordinary shareholders might hope for considerable dividends. They had no doubt had many rivals in trade, but he was sure there were none who could surpass them in punctuality or in the quality of the work, and he did not think there were many who could come up to them. They had struck rather a high note in their new buildings, where the machinery would be driven by electromotors, and the Company would then possess the most perfect workshop of its kind in the world. Well, that was singing their own praises. They might be quite sure that the Directors had thought over the matter carefully before they ventured to put a statement of that kind in the report. He had visited the works the previous day, and could see that they were very well arranged. Their engineer, Mr. Hatton, in the designs for those works, and in constructing them, was only acting as he had always done—most efficiently and economically—and the money was well spent. He was assured that even if their business was a little increased there would be such great savings in the way in which they could do their work that there would be a fair return on the cost of the works without any new business. They would be able to make cables which they had never made before, and owing to their inability to manufacture them they had lost orders—for instance, lead-covered cables. They were now making golf balls, and effecting considerable sales, and they hoped at a good profit, and that that business would also increase. Perhaps the shareholders would all take to golf, and send their orders to Mr. Sutton. It was interesting to note that no fault had been reported in any of the submarine cables since 1888. In 1888 they laid a cable in which there was a fault. If they could have given a substantial guarantee that the cable would not get worse, they would have received full payment of the contract money, but they were not strong enough to do it, and they were therefore mulcted to a certain amount. He was happy to say that the cable had not become any worse. and that it was working as well as ever. That company made considerable profit at their expense. Every shareholder had had an opportunity of looking at the balance-sheet, and he was quite willing to answer any questions. Of course, it was not desirable that minute facts relating to profit and loss should become known to their rivals, and therefore he would ask the shareholders who required any private information to go to the offices of the Company and ask for it. He then moved the adoption of the report and balance-sheet.

Mr. R. J. Jenkins, C.E., in seconding the motion, observed that the item of "B" debentures would have an important bearing immediately upon the ordinary shares, because the actual saving on the £18,000 was equivalent to a 1½ per cent. dividend to the ordinary shareholders. As being somewhat responsible by delegation from the Board, General G. Hutchinson and himself had carefully watched all the expenditure in regard to the extensions of the works. The whole of the capital, and a considerable amount in addition that some of the shareholders had supplied by taking up the preference shares last year, was being laid out in improving the works in such a manner as would not only benefit them in being able to take larger and more important contracts, but also effect an immense saving in some of the work which they had been in the habit of doing. They were also providing a siding which would save a large amount of money, by reason of their getting their goods direct into the works from the Great Eastern Railway, instead of having to unload them by vans and carts. During the past year they had opened a branch establishment at Melbourne, Australia, and although, as known to all City men, Australia was somewhat under a cloud, and particularly Melbourne, he was pleased to say that they had received from their agent there—a most experienced man, who had been connected with electrical work with important firms—good returns, and he was able to tell them of considerable sales which he had effected. Of course it was at first difficult work, but their managing director went out and ascertained the best goods required, and they were sent at the request of their agent. The speaker thought they might look for a fair return very shortly, and a good return as soon as the cloud lifted a little in the Australian markets. They had completed the manufacture of the Bahamas and Florida cable. Having done that, they were able to arrange an effective repair of one of the Western Union Telegraph Company's cables. That produced some revenue, but it at once established them in the position of cable-repairers. It informed people that they were quite capable of undertaking that class of work. and the repairs were effected on terms very favourable to the Western Company. The Chairman had stated that the accounts were open to the inspection of every shareholder. The system adopted in the accounts was laid down in the articles of association. He then seconded the motion.

Mr. Hughes-Hughes, in referring to the absence of a balance-sheet, strongly urged the publication of one. The shareholders would then know the position of the Company, and be more encouraged to go further into the concern.

Mr. Figgis supported the Directors in not issuing a balance-sheet. He thought the shareholders might safely leave that matter to the discretion of the Directors.

The **Chairman** observed that Mr. Hughes-Hughes had given them one very strong reason for not publishing a balance-sheet when he stated that the Directors would not have the pleasure of seeing any of the shareholders at the annual meeting The Board would take the matter into consideration, although at present he did not think a reason had been adduced to show why they should alter their custom. Every information would be afforded at the offices of the Company by Mr. Sutton, who would go into details. The result would be that Mr. Hughes would want to buy more shares, but he doubted whether any of the shareholders would wish to sell any. He then put the motion, which was unanimously adopted. He next proposed the declaration of dividends at the ratio of 7 per cent per annum on the preference shares, and of 5 per cent. on the ordinary shares. In doing so, he observed that the 7 per cent. payable on the preference shares was for the half-year, 3½ per. cent. having already been paid as an interim dividend.

Mr. Ball seconded the motion, which was carried.

The retiring directors Mr. Sydney Gedge and Mr. R. J. Jenkins, were re-elected, and Messrs Ball, Baker, and Co. were appointed auditors.

The passing of votes of thanks to the Chairman, the Company's works manager, Mr. Hatton, and the staff at the works and London office, concluded the proceedings.

BATH ELECTRIC LIGHTING COMPANY.

The second annual meeting of the shareholders of the Bath Electric Lighting and Engineering Company, Limited, was held last week at the works. Mr. Emile Garcke, chairman, presided.

The annual report was as follows: The Directors beg to submit the balance-sheet and profit and loss account for the year ending 31st December, 1892. The business of the Company has steadily increased during the past year, the number of lamps now connected being 6,420, as against about 5,000 at the end of 1891, and the receipts from current sold to private consumers have amounted to £2,129. 14s. 4d., as compared with £1,295. 13s. 7d. for the previous year. Notwithstanding, however, this large increase in the amount of current sold, the result shown by the profit and loss account is a loss of £300. This unsatisfactory result is due to a large number of the consumers still being charged on the rental system instead of by meters, so that the all-day supply which the Company is now giving has led to an increased expenditure which is out of all proportion to the increase of revenue. The rental system was introduced before the Company took over the business, and before the all-day supply was given. The Directors are now, however, terminating these arrangements as quickly as is practicable, and they firmly believe that the customers as well as the Company will benefit by the adoption of meters. Some of the customers who have already adopted meters have, as a result of greater economy in the use of the light, reduced their bills below the former contract amounts. This is an advantage to the Company, because it is better the customers should consume less current and pay for all they have than they should unnecessarily consume a larger amount of light for which, under the rental system, the Company is not paid. The electrical and other plant of the Company have been kept in thorough repair and perfect working order, and the several improvements effected in the station during the year have placed the Company in a satisfactory position for dealing with the increased demand for light. The Directors have during the year issued £800 debentures, bearing interest at the rate of 4½ per cent., part of the total issue of £3,000. The Directors have in view of the loss waived their fees for the past year.

The profit and loss account appended showed that the income had been £6,963. 8s. 7d., and the expenditure £7,270. 4s. 6d., of which £6,046. 3s. 5d. was due to the actual production of electricity, and £1,224 to salaries, rents, interest, etc.

The **Chairman**, moving the adoption of the report and accounts, said they had expended £4,838. 17s. 2d. on increasing the mains and apparatus, a general extension of the system enabling them to supply a larger number of customers. This expenditure had been met by raising a mortgage on the premises, and by issuing some debentures at a moderate rate of interest to the extent of £3,800. He did not think the balance-sheet called for any other comment on his part, but he would be happy to give any information that was required. He pointed out that in view of the loss in question the Directors had declined to take any fees. For two and a-half years the Directors had taken no remuneration whatever, and they had also enjoyed the time and services of Mr. Massingham, the managing director, without any remuneration other than what he obtained as a shareholder. The plant, the mains, and the apparatus by which they carried on their business generally, were in a very satisfactory condition. They had taken pains during the year, not only to maintain the efficiency of the entire system, but they had spent some money in addition to the figures appearing in the capital account on the ordinary working of the business which was fairly chargeable to the capital account, or rather to the maintenance of the plant. He had also to inform them that the plant had not only been ample for the present lighting requirements, but left them a very satisfactory margin for extensions, and they were thus prepared to carry on a much larger business than they did at present, without very materially increasing the capital account. He concluded by formally moving the adoption of the report of the Directors and the accounts.

Mr. Garrett seconded. They were working heart and soul in the business, and that it was their intention, if possible, to make it pay.

Mr. Ruddock thought the report was disappointing, especially to small shareholders. after the eulogistic terms in which the prospectus was set forth, but he thought they must all appreciate the generosity of the Directors in foregoing their fees.

Major-General Jervois admitted that things were not quite so satisfactory as they might have wished, but he looked forward to the future without any fear as to the Company's success. They had been, he pointed out, in a transition state. Looking at the great increase of customers they had had during the past year, they had no reason to despair—in fact, quite the contrary. They would probably be able to declare a very decent dividend in time to come, and, though it was yet early to prophesy, it ought to be next year. The rigid economy they practised must be continued, and he hoped, by taking advantage of the constant improvements being effected, they would be able to produce the current much more cheaply than they had in the past.

The report and accounts were unanimously adopted, and Mr. Butcher re-elected auditor.

ELMORE'S FRENCH PATENT COPPER DEPOSITING CO.

The shareholders of this Company met on Wednesday to consider the report of the committee of investigation It is absolutely useless to enter into any detailed report of this meeting, the result being to pass the following resolution: "We, the undersigned shareholders in Elmore's French Patent Copper Depositing Company, Limited, hereby signify our desire that the Company should be voluntarily wound up, with a view to reconstruction, under the supervision of the Court, on the following grounds—That the Company cannot, by means of its liabilities, carry on its business, and that the Company is unable to pay its debts; that Messrs. Harries, Wilkinson, and Raikes, solicitors, be instructed to institute the necessary steps for winding up accordingly; that we will attend the necessary meetings with a view to obtain the necessary resolutions; and that the Directors be called upon to convene a meeting for the purpose on April 5 next."

ELMORE'S PATENT COPPER DEPOSITING COMPANY.

On Thursday in last week an extraordinary meeting of this Company was held, the discussion giving practically the same information as with all these companies—the impossibility of continuing work without money. The result of the meeting was to appoint seven shareholders to investigate the affairs of the Company, and to report to a future meeting.

ELMORE'S WIRE MANUFACTURING COMPANY.

An extraordinary and general meeting of this Company was also held on Wednesday, and a similar result as the foregoing was come to—viz., the appointment of a committee of investigation to report.

BUSINESS NOTES.

Warminster.—The electric light is to be placed on the public fountain at Warminster.

Grimsby.—The electric lighting plant for the Grimsby Corn Exchange has been insured for £1,000.

Uppingham.—The electric light is about to be provided by the Grosvenor Company of Uppingham, Leicester.

Maidstone.—The Maidstone Board of Guardians think £24 too expensive for the proposed telephone installation.

Bridgend.—The Board of Trade has granted a provisional order for the establishment of electric lighting in the town.

West India and Panama Telegraph Company.—The receipts for the half-month ended March 15 were £3,017, against £2,895.

Crajova (Roumania).—Tenders are invited for the 27th inst. by the Municipality of Crajova for the electric lighting of the town.

Telephone Lines.—A survey has been taken for a proposed trunk line of telephone connecting Fraserburgh and Peterhead with Aberdeen.

Hospital-Lighting.—The London Hospital has received a donation of £3,000 from Baron Hirsch for the purpose of installing the electric light in that institution.

Slotting Machines.—A neat leaflet catalogue has reached us of the latest type of German planing and slotting machines, issued by Mr. H. F. L Orcutt, 145, Cannon-street.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,255.

Brighton.—Tenders are required by the Brighton Town Council for arc lamps, switches, and canopies for the lamps. Tenders must be sent in by April 4 to the town clerk, Brighton.

Windermere.—Power has been given by the Windermere City Council to Messrs. R. H. Fell and Son to lay cables under certain main roads for electric lighting and other purposes.

Insulators.—Contracts will be awarded for 825,000 porcelain insulators, in five lots, at Paris on March 30 at 11 a.m., 103, rue de Grenelle (Division du Materiel et de l'Exploitation Electrique).

Sunderland.—At the Sunderland Town Council last week, it was agreed to adjourn the question of telephone wires until the report of the expert had been received on the laying of electric wires in the borough.

Removal.—Messrs. Geo. Smith and Co., of Glasgow, ironfounders and makers of arc lamp-posts, having found their London premises at Dowgate-hill too small, have removed to 199, Upper Thames-street.

Epstein Cells.—The Epstein Electric Accumulator Company, Limited, announce that Mr. Frederick R Bluett has been appointed secretary to the Company, and that the offices are now at 213, Gresham House, Old Broad-street, E.C.

Edinburgh Tramways.—It transpired at the meeting of the Edinburgh Corporation that as the electric traction clauses are to be deleted from the Bill, and only the cable traction allowed to remain, all opposition is likely to be withdrawn.

City and South London Railway Company.—The receipts for the week ending March 19 were £880 against £896 for the corresponding period of last year, or a decrease of £16. The total receipts for 1893 show an increase of £1,007 over those for the corresponding period of 1892.

Pembroke Dock.—It is highly probable that the Admiralty will shortly take steps to introduce electric light at Pembroke Dockyard. An experiment in that direction has been for some time under contemplation. If it should prove successful, gas lighting at the dockyard will be abolished.

Electric Plant.—An opportunity is to be had, as can be read in the advertisement columns, for purchase of stock, plant, machinery, and tools of an electrical and general engineering trade in the West Riding of Yorkshire. Tenders to be sent in by April 12 to Messrs. Lakeman and Oliver, Park-row, Leeds.

Chiswick.—The clerk of the Chiswick Local Board, reporting as to further communications with the Board of Trade concerning the agreement with Messrs. Bourne and Grant *re* electric light, said that the Board of Trade suggested that Messrs. Bourne and Grant should form themselves into a company.

Newmarket.—Mr. Ed. C de Segundo, A.M I.C.E. and E.E., has sent in his report on the electric lighting of Newmarket to the holders of the provisional order. Mr. de Segundo estimates the cost of the necessary works for the immediate requirements at £13,000. The system recommended is a low-tension one.

Rotherhithe.—A letter was read at the last meeting of the Rotherhithe Vestry from the Electric Supply Corporation, giving notice that, after the expiration of one month, and in pursuance of the London Electric Supply Corporation Electric Lighting Order, 1889, they intended to lay trunk mains in Bush-road, Rotherhithe New-road, Raymouth-road, and Southwark Park-road.

Omnibus-Lighting.—Two 'buses at Sheffield, owned by Mr. Reuben Thompson, have been lighted electrically. The lamps are 6 c.p., the current being obtained from a storage battery, weighing 8lb., placed under the seat. The fittings have been supplied by Mr. T. Scott Anderson, of 59, Wilkinson street, Sheffield.

Moss Side.—The chairman of the Moss Side Local Board at the last meeting said he had made certain enquiries with regard to lighting the district with the electric light, and he hoped as a Board they would not rest satisfied until they had done all they could towards bringing about such a desirable improvement.

Camperdown (Australia) —On February 4th, an exhibition of the electric light was given in Camperdown (Victoria) by the Brush Company's representatives, with the view of enabling the local authorities to judge of the effect of this method of illumination before deciding upon its adoption or otherwise. The experiment was watched with keen interest by the inhabitants of the town.

Halifax.—The Halifax Sub-Committee suggest the building of a technical school in Hoywood-lane (site £3,600). They estimate that the building will cost £12,410, and the furnishing £4,000. Towards this subscriptions promised and grants represent £16,895. A largely-attended meeting unanimously approved the report, and deputed a representative committee to carry out the scheme and direct the school.

Electric Tramway for Llandudno.—At last week's meeting of the Llandudno Improvement Commissioners, Mr. J. Jones proposed that an electric tramway be sanctioned within the district of the Board, provided the route and other detailed arrangements be approved of by the Commissioners. Mr. S. Dunphy moved a direct negative, and upon a division the motion was rejected by a large majority.

Roger Dawson, Limited.—Mr. Roger Dawson, of 53, Berners-street, W., has formed his business into a private limited company, taking Mr. A. R. Cobbett, late of the firm of Arthur Cobbett and Co., Pall-mall, as co-director and manager of the non-technical parts of the business. The style of the firm will be Roger Dawson, Limited. We wish the new firm every success in their electrical and artistic fitting work.

Hanley.—At the Hanley Town Council meeting on Tuesday, the General Purposes Committee recommended that the tender of Mr. C. Cornes, of Hanley, for the erection of the buildings and chimney-shaft in connection with the electricity works, amounting to £2,990, be accepted; and that the borough surveyor be instructed to report on the details of the street-lighting by electricity within or adjacent to the compulsory area. These recommendations were confirmed.

Dalkeith.—Mr. John Chisholm, speaking at a special meeting of the Dalkeith Burgh Commissioners, with reference to the purchase of the gasworks, referred to the apprehensions concerning electric light being possibly introduced He thought this was a mere myth, as they would not have the water supply necessary. Even where electricity was in operation there had not been a decrease in the consumption of gas, as it was now being used for other purposes than lighting.

Windsor Castle.—The development of the electric light in Windsor Castle is still progressing. the latest operation being the introduction of two sets of the E.P.S. "K 33" accumulators. The storage capacity is equal to lighting about 200 16-c.p. lamps for 3½ hours. They will be charged with current during the night time ready for each succeeding evening, and in that way the running of the engines can be dispensed with during the day time, and any annoyance to the Queen will be avoided.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The Company's accounts to December 31 show a balance of profit of £157,093, after payment of three interim dividends. The Directors propose to distribute on the 19th prox. the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1892, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. The balance of £75,843 has been carried to the reserve fund.

Telephones at Llandudno.—The Llandudno Commissioners last week discussed at considerable length the question of erecting telephonic poles in various parts of the town. Mr. Elias Jones said that the number of poles already put up was a great eyesore, and if a hundred more subscribers could be had by the telephone company the place would be covered with poles. Mr. Dunphy assured the Commissioners that only about 10 additional poles would be erected in the town, the trunk lines having been constructed.

Barberton (South Africa).—Tenders are invited for the supply and erection, upon the company's estate, near Barberton, South African Republic, of machinery and plant, for the purpose of generating and transmitting 250 h.p. by electricity to various sub-companies, for the Moodie's Gold Mining and Exploration Company. Specification and conditions of contracts can be obtained from, and plans can be seen at, 8, Old-jewry, London. Tenders, together with specification and conditions of contract, must be sent to the head office of the Company, Pietermaritzburg, Natal, by May 3rd.

Richmond Clock.—A fine new turret quarter-chime clock has been presented to the new town hall at Richmond, Surrey, and a set of bells by Mr. Charles Burt, the mayor, Hillside House, Richmond, Surrey. The dials are lighted by electricity, and the clock has got all the latest improvements inserted from Lord Grimthorpe's plans. The work has been executed by Messrs. William Potts and Sons, Guildford-street and Cookridge-street, Leeds, from instructions received by them from Mr. Ancell, architect, London. Messrs. Potts also recently fixed a new clock at St. Luke's Church, Kingston, Surrey.

Lubricating Oils.—Sir Ughtred Kay-Shuttleworth stated in the House of Commons the other day, in answer to a question from Colonel Howard Vincent, that the only oils considered suitable for lubricating the machinery of Her Majesty's ships are mineral oils distilled from American petroleum and olive oil, neither of which are British products. Compound oils are largely used in practice, but the compounding is done after the pure oils are purchased, and thus an economy is secured. The contract for the supply of mineral oil for the Navy for 1893-94 has been placed with the Dee Oil Company, a British firm. The olive oil is imported direct.

Sewage at Finchley.—At the meeting of the Finchley Local Board last week, a letter was read from the secretary to the Electrical Purification Company, with a rough estimate of the cost for the treatment of one million gallons of sewage per 24 hours by the electrical process, at an annual expenditure of £1,054, exclusive of royalty. Mr. Jones said he was waited upon the other day by a representative of the company with regard to this matter, and he ventured to say that the Board would certainly not be disposed to try a new method until the present one had proved a failure. Information, however, could be obtained from the company's pamphlets, copies of which were on the table. No action was taken by the Board.

Electrolytic Separation Syndicate, Limited.—Registered by J. A. Maxwell, 97, Bishopsgate-street, E.C., with a capital of £25,000 in £1 shares. Object: to acquire certain inventions relating to methods for the electrolytical separation of the bases of salts and compounds of the same from saline solutions; and, with a view thereto, to carry into effect an agreement expressed to be made between C. T. J. Vautin of the one part and this Company of the other part, and to develop and turn to account the same. There shall not be less than two nor more than seven directors; the first to be elected by the first three signatories to the memorandum of association. Qualification: £100. Remuneration: £100 each per annum; chairman, £50 extra.

Lewes.—The Lewes City Council wish to adopt electric light, and, indeed, had granted money for the cost of wiring in consideration of the town being likely to have its own installation. This seems far off, and the sub-committee report there is no chance at present of the electric light being introduced. A little information on the cost of separate plant, by gas-engine and accumulators, should be provided to that committee. Mr. Kemp has the matter in hand, and the architect is Mr. Denman. The following is the list of the County Hall Committee: Mr. J. G. Blencowe, Mr. G. Boulton, Mr. E. C. Currey, Mr. J. Darbyshire, Major J. G. Edwardes, R.A., Mr. J. Farncombe, Mr. J. A. Gray, Mr. A. Hillman, Mr. C. R. Kemp, Mr. T. E. Ravenshaw, Mr. F. M. Wallis, and Mr. A. Weekes.

Watford.—At last week's meeting of the Watford Local Board, Messrs. J. G. Statter and Co. wrote that it had been proposed to form in Watford a company for lighting the town with electricity. The company had been formed, although it had not yet obtained a provisional order. The Earl of Essex had consented to become president. Mr. J. G. Statter had viewed the place, and reported that there was every prospect of the movement being a success. They proposed to conduct all their wires underground in the principal streets, and in no case would they carry them overhead without consulting the Board. Mr. Benskin asked what was the position of the Board in regard to the electric light. The Chairman said the company had simply given them notice they would apply for a provisional order, and the Board had better instruct the clerk to advise on the matter. This course was adopted.

Wakefield.—Councillor Smith enquired at the Wakefield City Council last week whether Councillor Moorhouse was in a position to give the Council any information as to the progress made by the sub-committee appointed on January 3 last for the purpose of instituting enquiries into the question of lighting the city by means of the electric light? This was a very important matter, and as it was some time since the committee were appointed, the ratepayers were anxious to hear what steps had been taken in connection with it. Councillor Moorhouse said he was obliged to Councillor Smith for giving him notice of the question as he came into the room. He could not possibly present any report, for the simple reason that the committee were still making enquiries. It was not true, as reported, that the Council had lost the power of securing a provisional order for lighting the city with the electric light. The sub-committee would report in due time to the Sanitary Committee, and through them to the Council.

Electric Pumping at Windsor.—A new and interesting feature has just been added to the admirable electric installation at the White Hart Hotel, under the charge of Mr. A. Farrow, at Windsor. Beneath that building, some 65ft. below the surface, is a chalk spring which, from a long-past period, has supplied the hotel with water of excellent quality. This was originally obtained by a manual pump; then, and up to quite recently, the pump was worked by steam, and this has now been displaced by an electric motor connected up with the dynamos which light the whole of the premises. This motor is one of Mather and Platt's "Manchester" type machines of 1 h.p. nominal, but capable of working up to 2 h.p., and with an electrical capacity of 50 volts and 20 amperes. As at present run, the motor can raise 200 gallons of water an hour, which is carried to storage tanks on the roof, whence it is drawn for the general service of the hotel. It also drives a "Blackman" fan for ventilating the larder; and, if need be, could be connected with and could drive a fire-engine.

Consolidated Telephone Company.—Notice is given that an extraordinary general meeting of the members of the Consolidated Telephone Construction and Maintenance Company, Limited, will be held at Winchester House, Old Broad-street, London, on Tuesday, March 28, 1893, at 12 o'clock (noon), when the following resolution will be submitted as a special resolution: "That the capital of the Company be reduced from £307,545, divided into 75,000 preference shares of £1 each, 75,150 ordinary shares at £1 each, and 224,850 ordinary shares of 14s. each, to £234,938, divided into 47,363 preference shares of £1 each, and 75,150 ordinary shares of £1 each, and 224,850 ordinary shares of 10s. each; and that such reduction be effected by returning the amount of £1 per share credited as paid upon each of the 27,637 issued preference shares of the Company to the holders thereof, and thereupon cancelling such shares, and by returning 2s. per share to each of the holders of the 224,850 issued ordinary shares of the Company, and by writing off each of the said 224,850 ordinary shares the sum of 2s. per share as being capital unrepresented by available assets."

Coventry Tramways.—At a meeting of the Coventry City Council last week, Mr. West called attention to the fact that negotiations between the General Works Committee and Mr. W. S. Graff Baker, the owner of the tramways, with reference to the equipment of the trams with electric traction on the overhead wire system, had come to a deadlock. At his request a letter from Mr. Baker was read, which intimated that he was willing, on the advice of some members of the Council, to reopen the negotiations, and also to accept certain modifications of the draft agreement. Mr. West thereupon proposed that the matter be further considered by the Council. Mr. Lee seconded the motion, and asserted that there had been an invincible obstinacy and a persistent determination to oppose the electric tramways, regardless of the wants of the population. Mr. Andrews suggested a reference to the General Works Committee, but this was met with noisy opposition. He caused some sensation by referring to a hole-and-corner meeting of certain members of the Council at an hotel in the city, where they tried to settle the matters that should be settled in the Council meeting. Mr. Booth retorted that many things had been settled at dinner parties and the like, and contended that in the interests of the town this matter should be taken out of the hands of the General Works Committee. After an animated discussion of nearly an hour's duration, Mr. West withdrew his motion, on the understanding that the matter should be dealt with immediately, and ultimately the matter was referred back to the General Works Committee, Mr. Lee withdrawing any alleged imputations.

Notting Hill Electric Lighting Company, Limited.—The Directors' report to December 31, 1892, states that the expenditure on capital account at the date of the last balance sheet amounted to £67,846. During the year a further sum of £9,055 has been expended, bringing the total to £76,900. Out of this total, £7,110 was expended on mains, and £1,535 on additional machinery rendered necessary by the increase in the area supplied. The extension of the mains southward into the Phillimore district has been carried out, at a cost of about £6,500, to the entire satisfaction of the Directors. The revenue for the year, which shows a satisfactory increase, amounted to £3,514, the revenue from sale of current being £2,519 for the 12 months, as against £999 for the previous seven months. The number of houses supplied has increased from 77 to 124, and the number of lights from 6,056 to 9,438. As the profits of the Company depend, after a certain amount of output is reached, upon the amount of annual revenue per lamp, with a view to encourage development in this direction, a sliding system of rebates has been instituted by means of which the charge for current to consumers whose lamps yield a gross revenue of upwards of 10s. a year, will be proportionately reduced, the minimum rate being fixed at 6d. a unit. The profit for the year amounts to £112, which compares with the loss of £555 (reduced by the return and postponement of undrawn Directors' fees to £305) for the previous seven months. The Directors have refrained from drawing any fees during the past year, and do not intend to draw any during the year 1893, until after the results of the working have been ascertained and the report presented to the shareholders.

Carlisle Public Library.—At the meeting of the Carlisle Town Council on the 14th inst., Mr. Ferguson moved the adoption of the minutes of the Public Libraries and Museums Committee, which included the recommendation that the library buildings should be lighted by electricity at an estimated cost of £1,600. With regard to the electric light, the Council must not run away with the idea that the £1,600 which it was proposed to expend would be altogether an addition to the cost shown in the original estimates. Their original estimate was to lay out about £3,000 in fittings. They had thought that, of that sum, about £800 would be required for lighting with gas; but they found that there was a general expectation that Tullie House should be lighted by the electric light. People expected to see it, and they would be disappointed if it was not adopted. The cost would be £1,600. That would provide two large dynamos and two engines which could be connected one with the other, or in the event of a breakdown one engine could be transferred to the other dynamo. It was not probable that both engines and both dynamos would be running at once, except when the whole building was lighted up. The Mayor said although they were spending more money upon the electric light, they would have their gas bills to deduct from the cost. He pointed out the great advantage which the use of the electric light would be, as compared with gas, in the preservation of books and pictures. He had had much experience in this matter, and however good and beneficial gas might be, when it came to a question of the preservation of books and pictures, the balance was enormously in favour of the purer light. The motion was put to the Council and agreed to unanimously.

Waterloo Electric Railway.—The committee presided over by Sir C. Dalrymple, on Tuesday had before them the Waterloo and City Railway Bill. The scheme which the promoters of the Bill seek power to carry out consists of the construction of an electrical underground railway, beginning at the Waterloo terminus of the London and South-Western Railway, passing under the Thames, coming out close to the northern approach to Blackfriars Bridge on the Victoria-embankment, and continuing to the Mansion House, where it will be connected with the lately authorised Central London Railway. There will be no intervening stations, the sole object of the undertaking being to connect Waterloo Station with the City. The only appearance against the Bill was entered by the London County Council, which body desired to have the Bill postponed until other claims are considered, and also wished for protection as regards the Victoria-embankment and their own sewers. After the case for the promoters had been opened by Mr. Pember, Q C., and Mr. Scotter (general manager of the London and South-Western Railway Company) and other witnesses had been taken, the committee found the preamble of the Bill proved, and proceeded to deal with the clauses. Mr. Cripps, parliamentary agent for the London County Council, brought up a clause which proposed that the construction of the works beneath the Victoria-embankment should be carried out to the satisfaction of the engineer to the Council. Mr. Pember, Q.C., pointed out that the works would be no less than 77ft. below the embankment. The Chairman said the committee were of opinion that it was sufficient to bind the company not to raise their level. A further question arose as to the construction of subways. The County Council asked for a clause providing that any subways made under the general powers of the Bill within the county of London, which came within 20ft. of the surface, should be constructed in accordance with plans and sections approved by the Council. Mr. Pember said he could not accept such a clause. The Chairman said that the committee were of opinion that the great thing to be considered was the convenience of the public, and did not think it necessary to insert the clause. The Bill was ordered to be reported.

Victoria Electric Railway.—The Edgware-road and Victoria Railway Bill came before the committee, on Tuesday, presided over by Sir J. Kennaway. The line is to be one for electric traction, running a distance of 4½ miles from Brondesbury (on the London and North-Western Railway) to Victoria. There will be seven stations—Brondesbury, Kilburn, Hall-road, Praed-street, Marble Arch, Hyde Park-corner, and Victoria. The capital is £1,200,000, with £400,000 borrowing powers. The scheme is opposed by several of the petitioners on the ground of possible injury to residential property. The counsel for the Bill were Mr. Pembroke Stephens, Q.C., Mr. Worsley Taylor, Q.C., and Mr. Hume Williams. The petitioners against the Bill were the Belgrave Mansions Company and the sub-lessees (Mr. Cripps, Q.C., and Mr. Lynden Bell); the Duke of Northumberland (Mr. Littler, Q.C., and Mr. Page); Lord Iveagh and others (Mr. Littler, Q.C., and Mr. Page); the Duke of Westminster (Mr. Littler, Q C., and the Hon. A. Lyttelton); St. George's Hospital (Mr. Giles); the owners in Grosvenor place and gardens (Mr. Cripps, Q.C., M. Lynden Bell, and Mr. C. G. Napier Trollope); the owners on the line of railway (Mr. Boyle and Mr. Tyrrell). Mr. Pembroke Stephens, Q C., having opened the case for the promoters, Mr. Primrose, permanent secretary of the Public Works Office, stated that the explanations that had been given by the engineers of the railway as to what was to be done under Hyde Park and at the refuge at Hyde Park-corner were satisfactory. Mr. Greathead, C.E., one of the engineers of the undertaking, examined by Mr. Taylor, Q.C., gave evidence as to the engineering difficulties of the line, and the manner in which it was proposed to construct it. Cross-examined by Mr. Littler: The depth below the street at the Victoria Station would be 47ft., and at Hyde Park-corner 61ft. There was no express provision in the Bill for connection with other lines by means of subways. By Mr. Lynden Bell: He did not think that the occupiers in Grosvenor place and gardens would feel any vibration from passing trains, and there was no reason to apprehend any subsidence. Mr. Thomas Bate, a resident of Kilburn for 33 years, was called to prove the demand for the extra facilities which the railway would afford. The committee then adjourned.

Aberdeen Harbour.—At the monthly meeting of the Aberdeen Harbour Board, Treasurer Bisset moved: "That it be remitted to the Docks and Pilotage Committee to report as to the propriety of having the harbour quays lighted by electricity." He took the opportunity on one occasion, when Prof. Kennedy, who advised the Town Council on the matter, was in Aberdeen, of putting before him a small plan of the harbour, and asking him to give a rough estimate of what it would cost to introduce the electric light. Prof. Kennedy gave him the estimate, and he found according to it that the annual expense of lighting the harbour by electricity would be about £1,320. That included the lighting of both sides of the Victoria Dock, the Commercial-road side of the Albert Basin up to the Market-street side of Messrs. Fleming's yard, and the Graving Dock, and included, of course, the expense of the lamps and their upkeep. He also got a statement from the officials at the Gas Office, and he found that the total sum paid last year for gas consumed at the harbour, including what was used for the leading lights, was £383. 5s. 2d. The Board would thus see that if they were going to go into this matter it meant a very considerable increase in expenditure, but he believed it would be a very considerable saving
used the harbour, notwithstanding the fact th
little additional expense to the Board.

at the harbour just now was just sufficient to enable people who had the full use of their faculties to keep out of the harbour, but was absolutely of no service to those who might be loading or unloading vessels during the night. Prof. Kennedy thought that he would be giving the Harbour Board for the £1,320 about 25 times as much light as they had at present. For that they would have to expend an additional £900, but Prof Kennedy assured him that there would be no difficulty whatever in disposing of the small oil lamps which shipowners used while loading and unloading vessels. Mr. Smith said he did not think there was any necessity for sending the matter to the Docks and Pilotage Committee He did not think the Board was in a position, even if they were willing to adopt the electric light, to spend £1,000 for it, although it would possibly be a benefit to shipowners discharging cargoes in certain parts of the harbour. He proposed that the subject be not remitted to the committee. Shoremaster Sinclair seconded. He thought the Aberdeen harbour would compare favourably with any harbour in the world in regard to lighting. The Board was not in a position just now to spend £1,000. Bailie Kemp seconded Treasurer Bisset's motion. He knew from his own experience that the light at the harbour was very insufficient. When he sat as shoremaster he heard a great deal of complaints about the harbour lights. After further discussion, the amendment not to proceed was carried.

Dundee.—The inauguration ceremony in connection with the installation of electric light in Dundee took place on the 15th inst. A number of the large establishments in the centre of the city have already been lighted up, while the series of lamps in the High-street were tested early in the week. At seven o'clock a large number of gentlemen met, on the invitation of the Gas Commission, at the electric lighting station. The company adjourned to the dynamo-room, where several speeches were made in celebration of the inauguration. Lord Provost Mathewson said the inauguration of electric light in Dundee was an important event in the history of the city. They had begun by lighting up a very small area, and they had only 40 customers at present. That might look very small, but when he reminded them of the completeness of electric lighting in Bradford, and that the Corporation there had begun with only 12 customers, they would admit that Dundee had done very well, and that they might look forward to a very successful future. Proceeding, the Lord Provost said that the area illuminated was a restricted one, but he had no doubt that electricity would be the light of the future. He thought that all present must be gratified at the magnificent appearance of the station, and he had no hesitation in saying that there was nothing superior to it in the kingdom. He was sure they all wished success to the electric system, and he had now pleasure in declaring the inauguration complete. Ex-Provost Brownlee said that the installation had been undertaken with feelings of anxiety, but when he said that it was so late as the month of August that they had begun the buildings, and having regard to their completeness and beauty, they would admit that those having charge of the arrangements had had a busy time of it. He could corroborate all that the Lord Provost had said in regard to the beauty of design and the convenience of the arrangement and equipment of the buildings, and he was convinced that there was nothing superior to them in any other part of the country. He thought the present was a favourable opportunity for stating that they were greatly indebted to Messrs. Urquhart and Small, the engineers, for the excellent design they had submitted and for the great attention they had given to every detail in connection with the installation. They were also indebted to Mr. Alexander, the architect, and to all the contractors, each of whom had carried out their contracts to the letter. He had much pleasure in proposing a hearty vote of thanks to the architect and the contractors. Mr. Urquhart returned thanks for the kind expressions made towards the firm he represented. While the speaking was going on the current was switched on, with the result that the High-street was brilliantly illuminated. The greatest interest was taken in the illumination, and large crowds assembled opposite the Town House to witness the lighting up. Satisfaction was expressed on all hands with the results obtained. The lamps were free from the slightest glare, this being due to the opal globes, which avoid the shadow nuisance so prevalent in connection with private arc-light installations. The light was full and steady, but its fine effect was to a certain extent lost by the fact that the gas lamps were also lit. At the close of the ceremony the company adjourned to the Royal British Hotel and dined together, Lord Provost Mathewson presiding.

Yarmouth.—At the Yarmouth Town Council meeting last week, the Electric Light Committee reported that, at their meeting on March 2, the following letter from the Local Government Board was read, dated December 28: "Adverting to the application of the Town Council of Yarmouth for sanction to borrow £15,000 for purposes of electric lighting, I am to request that the Board may be furnished with a copy of the electric lighting order authorising the scheme, and a general plan showing the positions of all the proposed works, the distribution of the wires, and the limits of the district to be lighted by the installation. The Board also desire to be supplied with information as to the type of generator to be used the power of the engine (steam or gas) to be provided, the method to be adopted for dividing the current, and the kind of lamp to be used. As estimate of the cost of the different works should accompany the plans." It was resolved to supply the information asked for. It was also resolved "That the Council be recommended to appoint Mr. Preece their engineer on the following terms: A payment of 5 per cent. on the contract price, on condition that the cost of the buildings (which would be carried out by the borough surveyor) be not included in the sum on which the commission is charged, and provided that in addition to preparing the specification, obtaining tenders, advising the Corporation on those tenders, and superintending the construction and completion of the works, Mr. Preece will supply such detailed information as may be required by the Local Government Board, and also attend the enquiry to be held before the sanction for a loan is entertained, both free of charge." The town clerk was instructed to enquire from Mr. Preece what his terms would be in case the works were not proceeded with from any cause. Mr. Martins moved the adoption of the committee's report. The outlay, he thought, was not a large one compared with the benefits they expected to derive. The recent public meeting was scarcely a reliable test of public opinion, for speakers who advocated the electric light were refused a hearing. The Surveyor, in reply to a question, said that applications had been received for about 2,000 lamps. The estimate provided for 4,000. Mr. Worlledge seconded the adoption of the report. Mr. Peaton moved as an amendment: "That the report now presented be referred to the committee for reconsideration, with a view to a modified scheme." Nothing, he said, should be done to peril the powers of the Corporation under the provisional order. He only differed from Mr. Martins as to the extent of the scheme The expenditure was put at £15,000, and by suggestion that afternoon had grown to £20,000, which was beyond the limits of prudence and the natural capacities of the town. What he urged was that just so much should be done as would bring the town within the privileges of the provisional order. He advocated a small basis of operations sufficient to meet requirements. An expenditure of £15,000 would mean a charge for interest of £840 per year, and this, with incidentals, would come up to £1,000, or 2d. in the rates. The Mayor said the surveyor informed him that if 2,000 lamps were used it would bring in £4,000, and the working expenses would be £1,100. If these figures were anything like correct the light would be self-supporting. The amendment was put and negatived by 25 to 13 votes. Mr. Williment then took exception to the proposed remuneration to Mr. Preece, whose fee, he said, at 5 per cent., was £700 He moved that the paragraph relating to his remuneration be struck out of the report. This also was negatived, and the report of the committee was then adopted.

Scarborough.—At the Scarborough Town Council last week the Sanitary and Lighting Committee stated that a report from Mr. Bernard Drake on the plans of the mains and works proposed to be carried out by the Scarborough Electric Supply Company, Limited, had been received and was referred to the Electric Lighting Sub-Committee to report thereon. The *Scarborough Post* has taken the advantage of Mr. Campbell Swinton's presence in Scarborough to have an interview with the managing director of the company, which is printed in very readable and accurate style. Mr. Campbell Swinton illustrated the theory of transformers with an iron poker and two coils of 200 and 20 turns: "If a circuit were established between the house wires and the high-tension current it would be cut off immediately. Such a thing never has happened in practice, but Major Cardew, the Board of Trade inspector, has invented a device by which if the current in the house wires should ever rise to above 200 volts—a perfectly safe pressure to handle—they would be automatically disconnected, and the current would, instead of entering the house, flow back by the earth to the dynamo. Yet, though there are thousands and thousands of them in use, the necessity for one to act has never yet arisen, except when they have been tested for experimental purposes." As to expense of wiring, he thinks 30s. a lamp a fair price. As to the actual cost of current "I can only refer to Mr. Preece's figures. He took the average cost of gas throughout the kingdom, and the average cost of electricity. Gas he reckoned at 3s. per 1,000 feet, and electricity he found to average 6d. per unit. Taking them at that rate, and allowing for the economies of which electricity is capable over gas, he calculated that the rate was about the same. I can also give you my own experience in lighting my rooms. I have a suite of three rooms and appurtenances, a small room for photographing. I have in my sitting-room five 16-c p. lamps., one 32 c.p., two 8 c.p., and six 5 c.p.; in my bedroom I have one 16 c.p. lamp; in other rooms another eight 8 c.p. In addition, I use the current for conducting experiments. The charge there is, as in Scarborough, 7d. per Board of Trade unit—that is to say, 7d. per current of 1,000 watts flowing for one hour. At that rate the lighting of these rooms for the past 10 months (which includes the worst part of the winter) has cost me between £10 and £11. More than that, in my offices, which are so dark that it is necessary to keep lights going all day, the lighting of five rooms with electricity has cost less for a year than one gas fire which I have. The meter is simply a light motor set on the main circuit and the number of turns it makes registers the current burned. It is like setting a small waterwheel to measure the water flowing from a pipe. The disadvantage about the alternating current, though, is this—that it is difficult to ensure the meter starting properly, so that it always tells against the company, and in favour of the consumer. The Durham College of Science, after they had had the light running some time, sent in a bill to the company for current supplied. The meter had become reversed in its action, and had run up an account against the company instead of the college. We shall arrange to give the usual discount of 5 per cent. to the consumer on payment of quarterly accounts within 14 days; we shall also have a sliding scale of discounts, the principle of which I will explain. The man who burns one lamp 10 hours, is a better paying customer than the one who burns 10 lamps for one hour a day. We shall therefore make an allowance for the man who burns his lamp most hours. A consumer with 25 lamps, who keeps them going 1,500 hours in the year, will get a discount of 14 per cent., while the man who burns 1,000 lamps for 500 hours will only get 7 per cent. The reason is this. The man who burns many lamps for few hours is making a big demand upon us at a time when the demand is heaviest; the man who burns lamps many hours is taking the current when fewest people are. As to motive power the alternating current is not good for that purpose. If we were met with any considerable demand for motors, we should have to lay a cable for continuous current, but we do not anticipate it as a possibility here. There will be no possibility of getting a shock from the current. The deaths in England since the introduction of electricity for lighting purposes have only numbered six, and in every case they were of servants of the companies who made some mistake in dealing with the current. During the whole of that time not a single member of the public or a consumer has been killed or hurt."

London County Council.—The Highways Committee of the London County Council agree to grant permission to the Post Office for the placing of a four-wire cable in the subway in Commercial-road. The same committee report that the Council on February 7 last, on their recommendation, formally disapproved of the works referred to in a notice, dated January 24, 1893, of the City of London Electric Lighting Company, of intention to lay mains in Blackfriars-road, etc., the reason of disapproval being the insufficiency of the particulars furnished by the company. The company on February 16 gave a further notice for the same works, but although repeatedly asked for the necessary particulars, it had on March 15, when the notice expired, failed to supply them; and the committee therefore authorised the issue of a second notice of disapproval, in order to prevent the works being proceeded with before the information required had been given by the company. The committee have considered a notice, dated February 22nd, 1893, from the Woolwich District Electric Light Company, of intention to lay mains in Globe-lane, High-street, Hare-street, Powis-street, Green's-end, Beresford-square, Wellington-street, Thomas-street, and New-road. This is the first notice received from this company; and details, which should have accompanied the notice of the proposed works, have been asked for, but have not yet been supplied. It is therefore necessary in this case also that the Council should disapprove of the proposed works; and it was accordingly recommended that the Council do formally disapprove of the works referred to. The committee further report that notices have been received from the Electricity Supply Corporation of intention to lay mains in Exeter-street and Wellington-street; from the Westminster Company of intention to lay mains in Morpeth-terrace; from the Kensington and Knightsbridge Company of intention to lay mains in Grenville-place; from the Notting Hill Company of intention to lay mains in Westbourne-grove — all these works are sanctioned. New mains by the House-to-House Company are also sanctioned. The committee have considered a notice from the London Electric Supply Corporation, dated 3rd March, of intention to lay distributing mains, consisting of concentric lead-covered cable drawn into iron pipes, in Upper Grosvenor-street, Park-street, Mount-street, Aldford-street, South-street, and Portugal-street. They see no objection to what is proposed, and recommend that the sanction of the Council be given to the works referred to in the notice upon the following conditions: That the company do give two days' notice to the Council's chief engineer before commencing the works, in the carrying out of which only one side of any thoroughfare shall be obstructed at one time; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that no pipes of larger size than 5in. shall be used; that no street boxes shall be constructed until the positions for, and the mode of construction of, them shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

Government Enquiry at Cardiff.—An enquiry was held at Cardiff on Wednesday last week before Colonel Charles Henry Luard, R.E., an inspector under the Local Government Board, into an application made by the Town Council of the borough of Cardiff to the Local Government Board for sanction to borrow £32,000 for purposes of electric lighting. Mr. F. C. Lloyd, deputy-town clerk, attended, with Mr. Harpur, borough engineer, and Mr. W. H. Massey, the electrical expert employed by the Corporation. There were also present Alderman Lewis, Mr. Sydney Walker, and Mr. Thomas Webber. Mr. F. C. Lloyd said that it was proposed to utilise land belonging to the Corporation, valued at £1,354. Mr. Wm. Harpur, borough engineer, said that for some years previously to 1890 the Brush Electric Lighting Company had an installation at Cardiff, and supplied electric light to a large number of customers, but in that year many of their overhead wires had become so decayed through age as to be unsafe, and the Board of Trade then insisted upon the wires of the company being placed underground. As a result, the company closed their station, and in October, 1890, ceased to supply light. Up to this time there was a steady and increasing demand for electric light, and, judging from the number of consumers which the Brush Company had, there appeared to be every reason to anticipate a fair demand for electric light and motive power when the works of the Corporation are established. The present application was to enable the Corporation to carry out their undertaking. The works now proposed to be established formed but one-fourth of what it was contemplated might be ultimately required, and the further additions would be added as the demand for electricity increases. The site adopted was at a distance of about one mile from the compulsory area of supply, but it had the great advantage of being alongside the Great Western Railway, where the coal and stores, etc., could be delivered directly into the works, and at a depth of 7ft. or 8ft. below the surface an abundant supply of water could be obtained for condensing purposes. He produced plans, etc., for the use of the inspector. Mr. W. H. Massey said that he was a member of the Queen's Household, M.I.C.E., M.I.M.E., M.I.E.E., etc. He had been actively engaged in electric lighting and electrical work generally since its introduction into this country, and during the last 11 years he had investigated and reported on several electric lighting schemes for both public and private purposes in Cardiff. He was well acquainted with the town and neighbourhood since 1878; and, although he had for many years, and of his own choice, not acted for local authorities in other districts, he readily undertook the duties of consulting electrical engineer in this case, believing that Cardiff was one of the few places in the kingdom where electric lighting might carried on at a profit, and where the whole of the work connected with the establishment and maintenance of the necessary works could be placed under the control of the borough engineer and his staff, thus avoiding the complications which had arisen in other towns where an electrical engineer had been specially appointed to take permanent charge of such works. He produced the following copy of the approximate estimate of expenditure approved by the Corporation:

High-tension mains, boxes, pipes, and laying	£3,500
Low-tension ,, ,, ,,	4,400
Transformers, underground chambers, switches, etc.	2,000
Arc-light mains, lamps, posts, boxes, pipes, etc.	3,100
Boilers, feed-pumps, etc.	2,500
Engines, steam-pipes, and condensers	3,500
Dynamos, switchboards, and accessories	5,000
Buildings, chimney, travelling crane, etc.	5,607
Railway siding and turn-tables	500
Site	1,354
Contingencies	1,039
Total	£32,500

Replying to the inspector, Mr. Massey and Mr. Harpur pointed out that in the compulsory area, situated in the main part of the town, they were obliged to complete their work by July, 1893, and they could afterwards extend their operations under their powers. Alderman Lewis said that under those powers they could compete with the gas company for lighting purposes. Mr. Massey said the Board of Trade had approved of the scheme. Mr. Sydney F. Walker desired to point out to the inspector the fact that there were coming into Cardiff four million gallons of water per diem, and they came in at a considerable pressure, which became larger as they went further back. The total was something like 1,000ft., and he would like to ask what objection there was to water power being used in place of coal. Mr. Massey said that Mr. Walker had devoted a great deal of time lately to writing to the local papers, but he (Mr. Massey) thought that Mr. Harpur and himself had finally disposed of the question already. They had been two and a-half years going into this water-supply scheme, and they had taken everything into account—water power, refuse destructors, and the rest. Mr. Harpur said, that with a life-long experience of waterworks he knew they could not possibly rely upon the regularity of the supply, nor perhaps upon the quantity. After further discussion, Mr. Walker expressed himself as satisfied, but wished the information had been given sooner. A discussion on incandescent *v.* arc lamps was then held. With reference to the proposal to use the Taff River, Mr. Massey said the scheme would cost £300,000 and save £6,000. The enquiry then closed, and the inspector visited the locality of the proposed station.

Edinburgh.—The following preliminary report by Prof. Kennedy on the electric lighting of Edinburgh was issued last week to the members of the Town Council: "In accordance with the request of the Electric Lighting Committee of the Town Council, I have made an examination of the northern half of Edinburgh with a view to the electric lighting of that district, and have made an estimate of the probable cost of the work, the probable annual expenditure, and the probable annual income from the sale of electric energy. I have pleasure in now placing on record the results at which I have arrived. I find that the total length of roadwork in the scheduled streets is about 12,000 yards. This includes the two sides of such streets as would be likely to require current on both sides, and the whole circuits of Moray-place, Ainslie-place, Randolph-crescent, and Charlotte-square. I have also included Rothesay-crescent. Of the length given, about 1,300 yards represent road crossings and other unproductive work, leaving what may be called the 'productive frontage' as about 10,700 yards. The completion of the distributing mains in all the important residential and commercial streets between Heriot-row and Princes'-street, and also the residential streets and terraces in the west to Donaldson's hospital, in the north, across the Dean Bridge, and in the east round the Calton-hill, including with these several less important streets in which connecting mains would advisably be laid, would involve about 13,960 yards of additional roadwork, of which at least 3,000 would be unproductive. The total roadwork for the distributing mains would therefore be 25,960 yards, and the total productive frontage about 22,660 yards. In addition there would probably be about 2,500 yards of additional roadwork for feeders, so far as they are laid unavoidably in streets where there are no distributing mains. Keeping in view the character of the different parts of the district to be supplied—with which several years' residence in Edinburgh has made me very familiar—I have estimated that if all the shops, hotels, clubs, etc., and all the large private houses (along the streets and roads included above) were to be supplied with light, they would use from 150,000 to 200,000 lamps of 8 c.p. or their equivalent. (The difference between these figures is affected chiefly by the use of light in the premises above the shops in thoroughfares like George-street.) I need not say that it will probably be a very long time before such a large demand for current as this exists. But I estimate that in three years, or thereabouts, after opening the station you will probably have to supply 40,000 lamps wired. There are, of course, special reasons which make it probable that the demand for electric light will grow very quickly in Edinburgh. I find that in London the cost of an 8-c.p. lamp per annum in an hotel or club is about 20s., in a shop about 8s. 6d., in an office about 6s. 9d., and in a private house about 5s. (these figures are reckoned on the basis of a charge of 6d per unit). Calculating on these rates, and allowing for the different classes of property in the district, I estimate your total income from 40,000 lamps of 8 c.p. at £17,100, which is practically 8s. 6d. per lamp per annum on the average. I think this is a low figure, but it is as well that you should be on the safe side. This estimated income corresponds to a sale of 342,000 units per annum, about half as much as was sold last year from the Davies-street station of the Westminster Electric Supply Corporation, which was visited lately by some members of the Edinburgh Town Council. Including reserve plant, there would have to be placed in the station (assuming the whole district to be served from one station) about 1,400 i.h.p. in engines, with the corresponding boilers and electrical plant. The probable maximum demand at the lamps would be equivalent to about 6,150 amperes at 100 volts. For your information I may say that this corresponds to a station from 15 to 20 per cent. larger than that which I am just now starting in Glasgow. The cost of it would, however, be greater in a somewhat larger population, as the mains to be laid are much longer. It is doubtful, also, if the conditions would allow so cheap a system of mains to be used as that which I have employed in Glasgow, and it is improbable that a site can be had so central as the Waterloo-street site there. I have made a preliminary estimate of the cost of such a station as I have mentioned, and of the whole system of mains and feeders necessary for the supply of the amount of electric energy which I have given above. From this estimate I conclude that this total capital cost may be about £85,000. It is probable that more careful estimates may very considerably reduce this sum; but it would be as well at this stage to assume that it is not too large. The sum I have mentioned includes buildings and chimney, plant of every description, the mains all complete and all roadwork (in connection with this matter I have been greatly helped by a very careful detailed estimate of cost of roadwork in the scheduled streets, which Mr. Cooper has been kind enough to prepare for me), and reinstatement of roads and paving. It does not include land, nor connections to customers' houses, nor meters (for these latter a rent is paid by consumers in the case of all existing electric stations). The price I have mentioned includes a sum of £6,710, representing the additional cost of an arc lighting plant for 110 arc lamps (with duplicate machinery and an extra boiler), such as has been put up in Glasgow. This plant would be sufficient to light well the principal streets of the northern part of the city. In my estimate I have assumed it to be essential that the system of supply should be one in which the consumers are connected directly to a low-tension network of distributing mains. The total sum I have given will be sufficient whether the network is supplied directly by low-tension feeders (220 volts) or by high-tension feeders (say 2 500 volts), with banked transformers, or on a modification of the "Oxford" system. So far as I have been able to work out the matter, there will not in your case be very much difference between the different systems in cost. But this and the other points which really determine the choice of system can only be settled after a detailed investigation. As to cost of production, I find it possible to form an opinion with very little difficulty. The total cost to you in salaries, wages, fuel, stores, renewals, and maintenance—by the time when you are selling 300,000 units per annum (including wages, and materials in maintenance of mains and all other distribution expenses)—should not be more than 2·5d. per unit sold. Establishment charges and general office expenses should not be more than 0·5d. per unit; making the total outgoings on works 3d. per unit. To this has to be added the cost of interest and sinking fund on your capital, which I do not work out, as I do not know the exact rate at which you obtain loans. If the sum borrowed were £100,000, and the total interest, etc., 3 per cent., it would amount to 2·4d. per unit on 300,000 units per annum. It would be possible for you to charge at the rate of 7d. per unit at first, and 6d. per unit after you had got into regular work with a paying output. So far as my opinion is concerned, however, I should certainly advise you, if you take up the work yourselves, to start boldly at 6d. per unit, with the object of increasing your output as rapidly as possible. You will notice that a very large part of the total cost I have given—the whole of the interest and fully half the other expenses—is really a fixed charge, and will certainly not increase until the plant has to be increased—that is, until you are selling at least 450,000 units per annum. The cost per unit therefore falls off very rapidly indeed as the total number of units becomes larger. I may also say that the cost of doubling the capacity of your plant and feeders (the distributing mains must be made large enough to start with) will not exceed £30,000, so that the cost per unit will decrease in a geometrical ratio as the station grows. I have left out of consideration the cost of arc lighting on both sides of the account. I assume that the current for this purpose would practically be sold at cost price. As to the time at which you can hope to make the undertaking pay, if you do the work yourselves, I think you can hardly hope that you will be able to do without a loss in the first year of working. You will no doubt pay all your actual expenses apart from interest on borrowed money; but I think it would be too sanguine to hope that you would do much more. During the second year of actual working, however, if the scheme is a well-thought-out one and thoroughly well managed, and if the financial arrangements are carefully made, I think you ought practically to clear all your expenses, including interest on capital, etc. I need hardly point out that to attain this result—which I feel sure can be attained—it will be necessary, not only that the system should be well schemed and managed, but that it should be energetically pushed by the staff of the department which you put in charge of it. I feel no doubt, as I have already said personally, that electricity supply in Edinburgh should prove exceedingly profitable, owing to various local conditions (among which the price of gas cannot be forgotten), if it is thoroughly well managed. In making these remarks, I hope it will be understood that I am not expressing any opinion as to the comparative advisability of the Town Council taking up the matter for themselves, or passing on their responsibilities to a company. The notes I have given are merely such as may serve, so far as they go, as part of the data on which this question will be decided. I will only urge one point very strongly—that if it be decided to hand the work over to a company, it should be an absolute condition that the company should be simply a *bonâ fide* local supply company, entirely and altogether free from any connection whatever with any contractors, even those of the highest repute."

The Lord Provost's Committee of the Edinburgh Town Council spent more than two hours last Friday discussing Prof. Kennedy's report. No decision, however, was come to. Some members were desirous of obtaining more information from Prof. Kennedy, and others wished to have a fuller report from Mr. David Cook, manager and engineer of the City of London Electric Lighting Company, who has already expressed concurrence with the opinion of the expert. The proposal that the Corporation should undertake the installation was favoured by some, while others were disposed to allow private enterprise to lead the way, and finally the meeting broke up without having come to any resolution.

Llandudno.—At the monthly meeting of the Llandudno Improvement Commissioners the following report, prepared by Mr. E. Paley Stephenson, C.E., the Board's engineer, was presented:

To the Chairman and Members of the Water and Gas Committee.—Gentlemen,—In submitting this report in response to a resolution passed by your committee on the 9th, and confirmed by the Board on the 15th February last, I must, to a certain extent, ask your indulgence, as the question of electric lighting is more or less a speciality, and, indeed, almost a branch of engineering which stands by itself. An engineer and surveyor to a corporation or local authority, however, is called upon to perform many and varied duties, and my object will be to place before you the different methods of production and distribution of electrical energy, the probable cost and the effects upon the future of the gas concern, with a view to putting you in a position to know whether or not it is desirable to proceed further in the matter. It will be unavoidably necessary in writing this report to use a few technical terms, and it may be well to give a definition of these before proceeding further: First, a volt is the unit of electrical pressure; second, an ampere is the unit of current; third, a watt is the unit of power, or pressure multiplied by current; fourth, a kilowatt, is 1,000 watts, or what is known as the Board of Trade unit, and is equivalent to $1\frac{1}{3}$ h.p.

With regard now to the report itself, I think the first subject I should put before you is a statement as to the principal systems in vogue, and they are, I take it, as follows: 1. High-pressure direct current. 2. Low-pressure direct current. 3. A combination of high and low pressure.

These three divisions may be subdivided into many classes, but I think it is only necessary to go into the question of No. 3, a combination of high and low pressure, and the two chief subdivisions of this system are: (*a*) Direct-current transformer system; (*b*) alternate-current transformer system. As most towns are adopting one or other of these systems it may be well to describe the two. The principle is the same in each case, which is to generate the electricity at one main station at a sufficient pressure to supply the required district and to then reduce it to a pressure at which it can safely be supplied to consumers, the high pressure being 1,000 to 2,000 volts, and the low pressure being 100 to 200 volts. The limit of low pressure as fixed by the Board of Trade is 300 volts and of high pressure at 3,000 volts, all above this being extra high pressure. The main difference in the two methods is the way in which the pressure is transformed; the direct system being reduced by rotating dynamotors and the alternate system by stationary transformers.

Blackpool and Southport.—Blackpool and Southport, amongst other towns, have recently decided to lay down an installation, and they have fixed upon these two systems. Blackpool after a very able report, which I had the privilege of seeing, prepared by a subcommittee, deciding upon the high-pressure alternating-transformer system, and Southport I think oscillating between the two. No doubt a very great deal depends upon the nature of the district to be supplied, whether it is compact or straggling, and many other circumstances, and I need not say more now than that as far

I can see the high-pressure alternating-transformer system appears to me to be the system most suitable to this town.

Distribution.—The distribution of the energy may either be by overhead wires or wires placed underground, but as I do not for one moment think that overhead wires would be tolerated for this purpose, all my calculations in this report are for placing the wires underground.

District to be Provided.—I submit a plan herewith showing that portion of the town which should, in the event of an installation being laid down, in my opinion be first provided with the means of distribution. It includes the Parade, from Church-walks to Craigside; Mostyn-street, from Church-walks to the North-Western Hotel; Church-walks, from Parade to Mostyn-street; Gloddaeth-street, from Chapel street to Mostyn-street; North Parade, from Mostyn-street to Parade; Lloyd-street, from Mostyn-street to Parade; Clonmel-street, from Mostyn-street to Parade; Vaughan-street, from Conway-road to Parade. The only portion, however, in which I would at present advocate public lighting is the Parade, from Church-walks to Craigside, the remaining portions being for the purposes of private consumers, the system, of course, being capable of extension from time to time as may be found necessary. In the event, however, of the Commissioners applying for powers to the Local Government Board, it would be well to include the whole of the district within the improvement boundary.

Number of Houses.—The number of houses in the district which I have mentioned, and which is enclosed by a pink border on plan (No. 658) is about 365, and assuming that 40 per cent. of the tradespeople in Mostyn-street, and 15 per cent. of owners of houses on the Parade and other roads mentioned would avail themselves of the improved light, we have 90 houses, or 25 per cent. of the whole, and, further, it may be taken that the average number of incandescent lamps in each house would be 15. This, you will see, equals 1,350 lamps. On reference to the plan again it will be seen that on the Parade, from Church-walks to Craigside, I have provided for the erection and maintenance of 33 arc lamps of 2,000 nominal candle-power, 22 of which would replace 36 Victoria gas lamps, from Church-walks to Nant-y-Gamer-road, and 11 which would be placed where at present there are no gas lamps—viz., from Nant-y-Gamer-road to Craigside

Distance apart of Arc Lamps.—There is considerable difference in practice as to the distance apart at which these arc lamps are placed, in London the distances being as follows: Near the Royal Exchange from 13 to 107 yards, the average distance being about 41 yards, in Queen Victoria-street 45 yards, and in Victoria-street 40 yards. Very much, however, depends in all cases upon the number of gas lamps aiding the arc lamps, and also upon the nature of the streets and atmosphere. In providing, as I have done, for 33 arc lamps, the average distance apart is 96 yards, and it may be thought, after the figures I have given, that this distance is somewhat excessive; but I am of opinion that even with this distance there would be found to be at least four times better light. I would add that gas lamps should not be placed at a greater distance apart than 60 yards, and that those on the Parade are on an average about 58 yards.

Necessary Horse-Power.—The necessary horse-power to provide this installation would be: 1,350 16-c.p. incandescent lamps at (say) 10 lamps per horse-power, 135; and 33 arc lamps at (say) ⅔ h.p. per lamp, 22; this equals 157. Or, say, 150 i.h.p. for the first instalment. It is usual, however, and, in fact, almost compulsory, to duplicate this power, and therefore it would be necessary to provide 300 i.h.p.

Available Water Power.—It may be well here to make a few remarks as to the water power available from Dulyn. No doubt if sufficient water power could be obtained it would be of great advantage to the Commissioners, as the cost in maintenance of any installation would be materially reduced, and further than this, it would be possible to supply Conway and other smaller places between the source of supply and Llandudno. I have, however, gone fully into the matter, and I find that it is impracticable; the only place where this water could be utilised with reason being, to my mind, just before it enters the service reservoir at Llanbedr, and here the horse-power at present available for this purpose is practically nil. Some 15 h.p. to 20 h.p. might be developed, but it will be seen by the figures which I have previously given that this amount would be practically useless. I have, therefore, abandoned this idea and have allowed in my estimate for a central station to be erected at one of the two places shown on plan, and marked A and B respectively; A being in the Commissioners' yard, and B on a plot of ground near the station.

Rate at which Electrical Energy could be Supplied and its Equivalent in Price of Gas.—Two very important points to private consumers are—the rate at which electricity could be supplied to them, and its equivalent to the present price of gas. Mr. Preece, the eminent electrician, has, I believe, stated that electricity supplied at 6d. per unit is equivalent to gas at 3s. per 1,000. This means in other words, that if one gets one unit of electricity for one-sixth the price of 1,000 cubic feet of gas it is practically the same cost. I am of opinion, however, though I do not like to differ from so high an authority, that this is taking too bright a view, and if it be assumed that an ordinary house gas burner will give off 12 c.p. with five cubic feet of gas consumed per hour, and that a 16-c.p. incandescent lamp will absorb 60 watts per hour, the result is that, light for light, the price per Board of Trade unit must not be more than one-ninth the price of 1,000 cubic feet of gas to be of equal cost. It will therefore be seen that in Llandudno, where the price of gas is 4s. 3d. per 1,000, that the price of electricity to the consumer should not be more than 5·66d., or a little over 5½d. per unit. At the end of 1892 the average rate of supply per unit by eight companies in the Metropolis was 7½d., varying from 7d. to 8d., and by 30 companies in the provinces 8¼d., varying from 4½d. to 1s. I think it may, therefore, be safely taken that the cost to consumers would be either a little over or a little under 9d., and this would mean about three-quarters as much again as the present cost of gas. For the purposes of this report I have assumed 9d. per unit to be the probable rate of supply for the first few years. The average cost to wire a house is about 25s., but this would be exclusive of the cost of lamps and the repairs to road and footpath. With regard to the proportionate cost of public lighting, it may be taken that the total cost of each Victoria triple-light lamp on the Parade is £3. 19s., and it may also be taken that the total cost of an arc lamp of 2,000 c.p. would be £20 per annum; therefore, the cost of lighting the Parade from Church-walks to Nant-y-Gamer-road by arc lamps would be £440, as against £142 for gas, and £220 for arc lamps from Nant-y-Gamer-road to Craigside; electricity costing in this case three times as much as gas.

Advantage of Electric Over Gas Light.—There are many advantages, however, in electricity over gas, both in public and private lighting, the chief, however, being in private lighting, as the following statement will show:

Gas.—There is considerable labour in lighting, especially in public lamps, and the use of matches, tapers, or paper is necessitated in private lighting. *Electricity.*—There is practically no labour in lighting in either public or private lamps. In public lighting a great saving would be effected, as on nights when the moon is sufficiently bright the lamps need not be lighted at all, for if it became overcast at any time the man at the central station could at any moment, by moving a switch, light the whole.

Gas.—The cost of re-decoration of rooms and of cleaning curtains, etc., is largely increased. *Electricity.*—The cost is practically reduced to a minimum, there being no bad gases or smoke given off.

Gas.—The effect upon many classes of tradesmen's goods is very damaging. *Electricity.*—There is no such effect.

Gas.—The atmosphere is affected and vitiated, and the room very much heated. *Electricity.*—The atmosphere is not affected at all, and there is practically no heating power in an incandescent lamp.

Gas.—There is an undoubtedly bad effect upon the health, and also upon a man's ability for work. *Electricity*.—It is stated that in the Department of the General Post Office about £600 a year is saved in increased work obtained from clerks and others, and fewer leaves of absence.

Gas.—There is always a danger of fire, especially when a naked light is near any curtain, as is very often the case, and there is also danger of explosion. *Electricity.*—Provided the installation is properly carried out, there is no danger from fire, and there is no possible chance of explosion.

Probable Effect on the Gas Concern.—In the event of the Commissioners laying down an installation in Llandudno, the question would undoubtedly be asked, What would be the effect on the gas concern? In order to obtain some accurate information regarding this point, I have written to the gas engineers of 15 towns where much of the lighting is done by electricity, and I put the following questions to each: 1. Are the gasworks in the hands of a private company? 2. How long is it since electric light has been used? 3. What percentage has there been in loss or gain per annum since the installation? I give the answers which I have received below, but as some of the gentlemen who have kindly given me the information asked for object to its publication, I do not mention the name of the town in any case, but simply give them in the order in which I received them:

A. In the hands of the Corporation. In 1889. Very little difference. An increase in consumers each year.
B. Private company. 1890. Considerable gain in gas profits since 1890. Electric light has been recently very precarious.
G. Private company 1886. No effect felt on the gasworks; dividend made each year, though perhaps it might have been better had there been no installation. Electric light undertaking has resulted in loss to the undertakers.
H Private company. 1889 Not much, if any, difference. Consumption of gas increases yearly.
J. Private company. 1889. Increase of gas each year, though would have been larger if electric light had not been used.
K. Private company. 1890. Has to some extent affected the revenue of the gasworks, but not much.
M. Private company (gas and water). 1888. A reduction from 15 per cent. to 8 per cent. on the two undertakings, but figures for gas only cannot be given.

It is well known that when electric lighting was first started a scare was created in the gas world. Many people, however, who had the foresight to buy shares at the reduced rates then offered have since had cause to be satisfied with their judgment. To go back further still to the period when gas lighting was first started, it was then thought by many that the manufacture of candles would be injuriously affected. This, however, so far from being the result, has been found to be the opposite. Again, when railways were first constructed, it was expected that many less horses would be required. This, also, has been found to be an error. From the few answers, with one exception, which I have given above, it will be seen, as I have always thought, that the gas concern will go on increasing year by year, though perhaps not at such a rapid rate as if gas only were used.

Powers.—There have been two Electric Lighting Acts under which powers would have to be obtained in the event of an installation being provided; the first being the Act of 1882, the second that of 1888. The main differences being that in the latter Act it is provided that no provisional order shall be granted to any private company without the consent of the local authority except under very special circumstances, and that with regard to purchase by local authority from any private company the time is extended from 21 years to 42 years. The terms of payment are much the same in both Acts, being the then value of all lands, buildings, works, materials, and plant of undertakers, which value is in the case of difference to be settled by arbitration.

Cost.—The next point of interest to the Commissioners, and, in fact, almost the most important point, is the question of cost, and in giving an estimate as to this it must be borne in mind that though I have gone into the matter fairly accurately with the limited time and particulars at my disposal, this estimate is more or less approximate. I estimate that the first cost of the installation, including lands, buildings, machinery, cables, arc lamps and columns, and repairs to roads, would be £15,000, and assuming that the money could be borrowed at 3½ per cent., and that the interest and capital thereon would have to be paid off in 25 years; I further estimate the annual cost of maintenance, with a sum for depreciation of plant, at £1,435. To meet the above expenditure it would be necessary to produce a unit of electrical energy at 5d. and sell, as before stated, at 9d. I am of opinion that this could be done, Mr. Preece having stated that the average cost to nine large companies in London in 1892 was 4 76d. or 4¾d. per unit. Taking the above figures, I further estimate that the difference between the rate of generating the energy and the rate of supply to private consumers would be £1,667, thus leaving a small profit; which, as it will increase year by year in proportion to the number of persons availing themselves of the light, will soon allow of the reduction in the rate of supply. I have previously given the cost of public lighting, and this amount would, of course, have to be paid out of the rates. In conclusion, gentlemen, I would like to point out that electric lighting has now reached a stage which may be considered as beyond experimental; and, in fact, as far as the lighting of private houses, shops, and public buildings is concerned, it may be said that it has almost reached perfection. I admit, though, that the public lighting of streets has perhaps, not yet reached its zenith. The result to Llandudno would, I am convinced, be to its ultimate good; the town being more attractive, and as a consequence more people visiting here, and it follows that more money would be spent, and ratepayers would, therefore, indirectly reap the benefit. The day, to my mind, is not so very far distant when towns such as this will be compelled to provide an installation in order to compete with their sister watering-places. such as Bournemouth, Brighton, Blackpool, Eastbourne, and Southport. The Commissioners have the power to contract with any person or persons for the supply of electricity and, as before stated, to buy over the whole undertaking at the end of 42 years or longer periods. I would, however, strongly recommend this Board that when, if ever, it is decided to proceed with the work that it be kept in the hands of the local authority, and that tenders and complete specifications be invited from the very best firms, with a view to the firm selected carrying out the work and maintaining the same for a term to be agreed upon; the whole concern to be then handed over to the local authority.—I have the honour to be, gentlemen, your obedient servant,

"E. Paley Stephenson, A.M.I.C.E.,
"Engineer to the Board.

"Llandudno, March 3, 1893."

Mr. John Jones (Central-buildings) moved that the report be referred to the new Water and Gas Committee, and that in the meantime the report be printed (1,000 copies) in pamphlet form, so that all the ratepayers can have a copy. This was carried.

PROVISIONAL PATENTS, 1893.

March 13.

5355. **Improved means for rendering the sparking of commutators, switches, fuses, and the like, harmless in explosive atmospheres.** George Rolf and William Charles Mountain, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

5406. **Improvements in electric railway signalling.** Frank P. Schlosser, 55, Chancery-lane, London.

5419. **A new or improved manufacture of electric switches.** Herbert Henry Cass, Norfolk House, Norfolk-street, London.

March 14.

5470. **Railway electric fog signals.** Harry Sibery, 36, North-street, Ashford, Kent.

5486. **Improvements in commutators for dynamo-electric machines, and method of constructing the same.** Alexander William Meston, 55, Chancery-lane, London. (Complete specification.)

5495. **Improvements in or relating to the electro-deposition of metals.** William Phillips Thompson, 6, Lord-street, Liverpool. (Franklin Leonard Pope, United States.)

5505. **Improvements in apparatus for moulding the bodies of electric switches, bell pushes, ceiling roses, and other like articles, in china and earthenware.** Henry Watkin, 23, Southampton-buildings, Chancery-lane, London.

5525. **Improvements in electrolytic apparatus for decomposing chloride of sodium or potassium in solution, and for leading away the products of decomposition.** Trevenen James Holland, 6, Bream's-buildings, Chancery-lane, London.

March 15.

5580. **McLachlan's electric stern attachment for the propulsion of rowing-boats, etc.** Edwin Augustus McLachlan, 55, Brighton-road, Stoke Newington, London.

5594. **Improvements in the arrangements for working railway signals electrically.** Illius Augustus Timmis, 2, Great George-street, Westminster, London.

March 16.

5638. **Multiple change-over mechanism for electric arc lamps.** William James Davy, 41, Wandsworth Bridge-road, Fulham, London.

5639. **Multiple telegraphy.** Jeremiah McCraith, Melton Mowbray, Leicestershire.

5652. **Improvements in switches in connection with electricity.** John Robert Kay, 28, Granville-terrace, Blackburn.

5655. **Improvements in electric arc lamps.** Charles Richardson and Edward Geisler Herbert, Cornbrook Park-road, Manchester.

5684. **Improvements in portable electric primary batteries, and in their application to miners' and like portable lamps.** Mary Perry Tuckerman and Alfred Douglas Mackenzie, 55, Chancery-lane, London.

5694. **Improvements in apparatus for the electrolytic decomposition of solutions of chloride of sodium and potassium.** James Charles Richardson, 6, Bream's-buildings, Chancery-lane, London.

5698. **A method for lighting by electricity all descriptions of wheeled vehicles.** Stuart Robson, 45, Holland-road, Brixton, London.

5701. **Improvements relating to the coating of articles with metallic alloys by electro-deposition.** Sherard Osborn Cowper-Coles, 45, Southampton-buildings, Chancery-lane, London.

5709. **Improvements in the cores of armatures for dynamos, magneto machines, motors, and other purposes.** Henry Francis Joel, 44, Lavender-grove, Dalston, London. (Complete specification.)

March 17.

5715. **A new and improved depolariser for galvanic batteries.** Osmond Fergusson, 190, Eglington-road, Woolwich, Kent.

5720. **Moseley's simplex burglar and thief-proof electric alarm.** George Moseley, 23, Eden-street, Kingston-on-Thames.

5771. **Improvements in apparatus for electrical lighting.** Paul Scharf, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5778. **An improved process of manufacturing bleaching solutions by electrolysis.** Alfred Julius Boult, 323 High Holborn, London. (O. Knœfler and Fr. Gebauer, Germany.) (Complete specification.)

March 18.

5844. **Improvements in storage batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Max Hartung, Germany.)

SPECIFICATIONS PUBLISHED.

1892.

3234. **Electrical switches.** Snell and others.

3427. **Electric arc lamps.** C. A. J. H and H. E. R. Schroeder.

4494. **Electromagnetic solenoid apparatus.** Andersen.

7361. **Distributing electricity by alternate currents.** Spence and Deakin.

18732. **Arc lamps.** Fairfax. (Schuckert and Co.)

19665. **Telephonic apparatus.** Hooker.

1893.

78. **Electromagnets.** Varley and Jones.

510. **Electric transmission of power.** De Pass. (Rice.)

1356. **Electric gas lighting.** Sloss.

1502. **Secondary batteries.** Thompson. (Correns.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3 3/16
— Pref.	—	2 3/16
City of London	—	12¾
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4⅛
London Electric Supply	5	¾
Metropolitan Electric Supply	—	5½
National Telephone	5	5¼
St. James'	—	8
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Japan.—It is being contemplated to establish an electric tramway between Atami and Odawara, Japan.

Rottingdean Electric Railway.—The Bill for the Rottingdean electric railway has passed the second reading.

Dundee.—The current in Dundee was turned on last week to several establishments, including the Royal Exchange installation.

Editorship. — An editor, capable of writing on mechanical subjects, is wanted for a technical journal, by "854 X, 67, Fleet-street."

Vienna.—A report on the general condition and efficiency of the Vienna telephone system has been prepared by Dr. J. Hopkinson for the Vienna Company.

Turbines.—A paper was given on "Turbines" by Mr. C. Drysdale at the last meeting of the Electrical Engineer Students, Mr. Kempe being in the chair.

Electro-Harmonic.—The next smoking concert will be held on Friday, April 7. Ventriloquism and humorous sketches will be interspersed with the electro-harmony.

Obituary.—The death is announced of Mr. J. P. Hofstede, director-general of posts and telegraphs in Holland, at the age of 70 years, after 53 years of service.

Rhone.—An installation of 200 h.p. is building at Ardillats (Rhone) to utilise water power and distribute electric energy to Benjeu and Belleville, distant three to eight miles.

Saverdun.—A central station has been erected at Saverdun, Ariège, France. A turbine supplies 40 h.p., and serves 18 five-ampere arc lamps and 170 16-c.p. lamps. The cost has been £1,600.

Snow - Ploughs.—M. Ch. Courgoulier, 60, Calea Victorei, Bucharest, Roumania, states that snow-ploughs are required in Roumania, where the trams are sometimes stopped for three weeks with snow.

London Electric.—Our prognostications with reference to the London Electric shares are beginning to be justified, and the nominal price—which had reached a very low-water market—has risen 100 per cent.

Karlsbad.—An electric railway is to be constructed at Karlsbad. The town authorities desired plans, and Messrs. Ganz and Co. having prepared them, have offered same to the former for 3,000 florins. It is possible that the projected line will be put up for public tender.

Thomson-Houston.—A French company has been formed to work the Thomson-Houston patents, under the direction of M. Thurnauer, general manager of the Thomson-Houston European companies. Here will be likely opportunities for young electrical engineers who know French.

Station-Lighting.—Electric light is to invade the gods, and will be found on Mount Parnassus—in other words, the railway station known in Paris by the high-sounding title of Montparnasse will be lighted shortly by the Cance Company throughout with the new illuminant.

Utilisation of Water Power in India. — An instance of the use of water power by electricity in India, on a small scale, is a plant to be put up at Delhi by Messrs. Tellery and Co. The River Jumna will be made to turn a saw-mill, at a distance, by means of electrical transmission.

Army Searchlights.—The recent demonstration at Huddersfield of the army searchlights was hardly a success, on account of the batteries not being up to their work. We see that at Nice the regiment of artillery has recently carried out night manœuvres by the aid of electric searchlights.

Kaposvar.—A concession for 50 years for the public and private lighting of this town is offered, the whole of the plant, etc., passing into the hands of the town at the end of that period, without any payment whatever. Particulars may be obtained of the Stadtkommune, Kaposvar, Hungary.

Vegetation Exterminator.—A curious application of electricity is that for exterminating vegetation in tropical climes. A strong current is to be sent through the adjacent ground when a car is moved along the track, and this is supposed to kill the rank vegetation which grows along railway beds in tropical countries.

Hobart Electric Tramway.—The latest advices from Australia state that work in connection with the Hobart electric tramway is steadily progressing. Nine cars had come to hand, and were being rapidly put together. The generating shed is nearing completion, and the boilers were expected in a few days, the vessel being then due.

Telegraphy Between Trains.—Experiments have been made in Algiers with a system, devised by M. Etienne, of telegraphing to trains in motion from a railway station, between two trains, and also to stop two trains moving in opposite directions on the same line. The experiments are reported to have been successful, but no information is given concerning the system.

Temperature in Photometry.—Mr. H. Leicester Greville, chemist to the Commercial Gas Company, has an article in the *Journal of Gas Lighting* on an unconsidered error in photometry. This error is the influence of temperature, and he shows that in testing the candle-power of gas with the air varying from 46deg. to 73deg., the candle-power varies from 13·9 candles to 16 c.p.

Papers.—At the Institution of Engineers and Shipbuilders in Scotland a paper by Mr. Henry A. Mavor, on "Belting for Machinery," was discussed, and much important information elicited regarding the forms and speed of belts, power transmitted, etc. The discussion was adjourned to next general meeting. A paper was taken as read on "Testing Machinery and Electric Recording Apparatus," by Mr. James Barr.

Electric Welding.—N. Slaviankoff describes ("Ghornu Zhurnal," 1892) a method devised by him for electrically welding and repairing broken pieces of machinery. The work to be repaired is attached to one pole of a dynamo, and the metal to be cast is melted by electric arc in a special tool and falls on the object in a molten state. A description of the tool is given with the drawings and directions for different work with cost.

Free Pass.—Now is your chance, gentlemen of the quill! A Pressman visiting Chicago Exhibition is offered a first-class free pass in return for a few articles by a newspaper hiding itself under the algebraical sign of "36 *y*" at 67, Fleet street. The least such a pass is worth would be, we suppose, £30—and who could not knock off a few articles when carried free to the White City? Thus is illustrated the chances that fall in the way of intending visitors to the Fair.

Paddington Electric Railway.—The promoters of the Paddington and Victoria Electric Railway announce their intention to recommit the Bill before Sir J. Kennaway's committee. They have decided to wait for a while and enter into negotiations with the authorities at the Central Institute and the Royal School of Science, to see wheth the substitution of cable traction for electrici part of the line would not meet the scientific objections of the professors.

Windsor Telephones.—The trunk line for telephonic communication between London and Reading is now nearly completed, and the National Telephone Company propose to establish a telephone exchange at Windsor and Eton, at a yearly subscription of eight guineas for communication within a radius of one mile of the local exchange. Through communication by trunk lines to London and provincial exchanges will be provided for a small additional fee.

Electricity in Textile Industries.—The large carpet works at Meffersdorf, Bohemia, which introduced some time ago electricity as a means of transmitting power from the general works to a distant factory, have now increased the plant in consequence of the satisfactory results obtained by the preliminary machinery. The hope is expressed that this installation will lead to the adoption of electricity for power purposes in the important textile district of Reichenberg.

A Pioneer Inventor.—The *doyen* of electricians, M. Archereau, the inventor of the first arc lamp regulator, says the *Bulletin Internationale*, has just died at Paris. He was also one of the inventors of the agglomerate carbons, but in spite of these useful discoveries Archereau became so poverty-stricken that the newspaper *Figaro* a few years ago had to come to his succour. Latterly, however, he had found a modest position that allowed him to live, if not in luxury, yet without pain.

Electric Mining.—At the last meeting of the Mining Institute of Scotland Mr. David Hunter contributed a paper on "Some Practical Results of the Application of Electricity to Mining Operations." He maintained that the success of the application of electricity to mining was now beyond question, the only obstacle being that everybody was waiting to get the benefit of everybody else's experience. He went on to describe an electric plant that is in use at Bent Colliery, Hamilton, the results of which had been all that could be desired.

Champs Elysees Station.—The Compagnie du Secteur des Champs Elysées, in Paris, have just inaugurated their first central station on the Quai Michelet, before a large gathering, with plenty of champagne. They have already begun the supply by alternating currents, but they have found that the Hillairet alternators do not work well coupled in parallel, so that it is expected the whole system of electric mains will have to be changed or modified. The mains are of the Berthoud-Borel concentric type, manufactured by the Cail Company,

Santamaria.—The Italian town of Santamaria, Capua Vetere, which has 30,000 inhabitants, will be lighted by electricity. The street-lighting is to be provided by 23 eight-ampere arc lamps, and the private lighting will be carried out by 84 32 c.p. and 210 20 c.p. The concession has been given for 35 years. The central station is being erected by the firm of E. G. Neville, of Venice, and comprises four Cornish steam-boilers and two horizontal steam-engines—one of 150 h.p. and another (spare) of 80 h.p., driving alternators. The plant will be ready by October.

Sheffield.—A new theatre of varieties has been opened in Sheffield, under the name of the Grand, and is fully fitted by electric light by the Sheffield Electric Light Company. The electric light is used everywhere, even for footlights, with a reserve of gas. There are for the body of the hall four 12-light electroliers, with vari-coloured globes, and around and about the balcony are numerous pendants, with brilliant cut-glass globes. An electric attachment makes known in the saloon the number of the "turn," and gives thus an indication of the artists on the boards.

Water Failure.—An incident which illustrates the need for constant forethought in central-station working occurred at Windsor last week. It appears the waterworks people opened the road to put in a new stop valve in their main, and in order to do this the water was shut off for some time. The electric-light company had no notice and ran short of water, having to stop their engines. The company had already arranged for large tanks in case of emergency, but they could not expect to be aware of the waterworks wishing to stop the supply without notice.

Smart Telegraphy.—The result of the University boat race, telegraphed by the Dalziel Agency through the French Transatlantic Cable Company to America, was received in New York two seconds after it had been despatched from London, and three seconds after it was known at Mortlake. This is one of the smartest telegraphic feats on record. At 4.34 the pistol was fired, and the crews started. The race was over at 4.52 47secs. The name of the winning crew was received in Dalziel's office in the Strand at 4.52 48secs., and at New York at 4.52 50sec., Greenwich time.

New Books.—In their "Specialists' Series" Messrs. Whittaker and Co. will issue a work on "The Dynamo,' by C. C. Hawkins and F. Wallis, and also a new edition of Sir David Salomon's work on "The Management of Accumulators." They have in preparation an introductory work on "Electricity and Magnetism," by S. Bottone; the same author's little popular "Guide to Electric Lighting" has rapidly passed through a first edition, and a second will be issued shortly. Mr. W. Perren Maycock has completed the second part of his work on "Electric Lighting and Power Distribution," and it will be issued in a few days.

The Late Mr. Mercer.—The sudden and mysterious death on the South-Eastern Railway of Mr. E. T. Mercer, late manager of the Hastings electric light station, was recorded recently. He leaves a widow and four children, and a subscription is started on their behalf by Mr. T. Burton, the secretary of the company. Mr. Mercer was, we believe, a member of the Old Students' of the City Guilds; he was a hardworking man who had risen by his own exertions. We hope the subscription for his wife and children will bear sufficient fruit, and that interest will be shown in these little ones left without their support and protector.

Direct-Current Transformers.—The Compagnie de l'Industrie Electrique, of Geneva, have received orders from the Popp Company for 26 direct-current transformers, from 2,500 volts and 250 amperes down to 100 volts. The main feature of the new transformers is that the primary and secondary circuit are not wound on the same armature. Two separate dynamos are used on separate bed-plates, coupled by elastic coupling. This form of direct-current transformer has been adopted, as it has been found that the usual form with both high and low pressure windings on the same armature does not afford perfect security of insulation.

Three-Wire Patent.—The adoption of the three-wire system in Hull is not looked upon as an unmixed blessing. The Corporation have had to pay the royalty of £2. 10s. a year per ton of copper used; the quantity already utilised is 22 tons, and the royalties altogether due will amount to nearly £300. The Corporation propose to extend the system, and will have to pay heavily for the next three years at least. It is feared also that the patent rights may be extended. The Hull Electric Lighting Committee are feeling rather sore about it, as they fancy that the two-wire system would not have been more costly, and at first would have been equally as good.

Edison Lamps.—The Beacon Lamp Company, which achieved such notoriety over the Goebel lamp, has, it is said, made some amicable arrangement with the General Electric Company to manufacture lamps at a shilling each, and sell them to the company owning the Edison patents. This may be only a blind to further tactics, or a serious attempt to keep the plant going. A new company, the Green Electric Lamp Company, has been started to make a lamp to cut out Edison entirely. Mr. Henry Green, of Hartford, is the inventor, and it is claimed that the new lamp can be renewed any number of times at a trifling expense, and by a very simple process.

Pacific Cable.—At the International Postal Conference at Brisbane, the Hon. J. G. Ward, New Zealand, moved the following resolution, seconded by the Hon. John Kidd, New South Wales: "In the opinion of this conference, the time has arrived for establishing a second cable route, *viâ* the Pacific to Vancouver, touching at such places as may hereafter be agreed upon." In the course of the debate, Mr. Unmack, Postmaster-General, Queensland, stated that his colony had not entered into any agreement for the extension of the New Caledonia cable, but that he was free to support any fair proposal for laying a Pacific cable independently of the Eastern Extension Company.

Accumulators.—"Of all the batteries on the land, there's none like E.P.S."—is or should be the motto of the Electrical Power Storage Company. They are known far and wide; wherever, in fact, electricity has penetrated, and now that they are cheaper, they will be more used and more appreciated. We have received the catalogue and price-list, accompanied by the kind of notice that contractors and engineers appreciate: "We are considerably reducing our prices on and after the 3rd prox." Easter will therefore be a mark of some importance in the electrical circles, for this reduction runs as much as 15 or 20 per cent., and there is that with which to make a profit in the difference. This all shows a healthy state in the accumulator market, and what with firms failing or dropping out here and there, we require a stimulus in electrical trade. Truth to say, dynamos are cheap enough, accumulators though dear, are getting cheaper, and lamps will before long be at the price of chimney-glasses. Extended business is the watchword of the future, and the reduction in E.P.S. cells which we note is one of the means to this end. The atalogue contains full particulars of all kinds of accumulators and testing instruments, cut-out switch, and other charging and discharging apparatus are shown.

Steam-Engine or Dynamo Efficiency.—One of the speakers in the discussion at the recent National Electric Light Association meeting said: "We suffer a relatively heavy loss, because up to the present time our incandescent lamps give us but a small portion of the energy they receive—in the form of light. I estimate that out of the 1,000 h.p. that the central-station man buys in the form of energy in coal, he may be able to sell 2·8 in the form of light. He has lost in the various steps about 930 h.p. before he has eached the dynamo. In the electrical apparatus down to the lamp he loses continually. I am glad to know that the steam engineers are attacking this problem of waste energy in the steam plants in a way that promises success." We have alluded to the improvements in the steaming power of water-tube boilers, but the greater part of this enormous loss is almost unavoidable under present conditions of working. Perhaps when we work with cold-engines and liquefied air supplies the power, a greater engine efficiency may be looked for. Here, indeed, is where professors find their true research work—to show engineers other ways of obtaining energy from engines and insisting on the points where saving can be made in present forms. Every engineer ought to have a diagram in his office, for the stimulation of the younger generation, showing the percentage of useful effect on present machinery per ton of coal.

Newspaper Index.—It is difficult to imagine anything fresh in the way of newspapers, yet we have received one this week that is in every way worthy of support. *Curtice's Index of Periodical Literature* is a weekly indexed catalogue of many hundreds of references to important subjects dealt with in daily, weekly, and monthly papers and journals. Messrs. Romeike and Curtice's press-cutting agency is well known, and though it was but a step from issuing cuttings to publishing an index to them, this step has not before been taken. Now a reader interested in any subject can see what references are made to it in the articles in all newspapers, be it on politics, engineering, teaching of languages, electricity, pictures, books, poems, or personalities. The items are carefully tabulated, and any article will be sent free on receipt of the price marked, or will be type-written at 2d. a 100 words. Naturally, the references are not as full in the first number as they will be in the future, still the *Index* contains some 2,000 references, and we have tested it with regard to several subjects with satisfactory results. The technical parts are not so full as the others, but journals can remedy this by sending to Mr. Edward Curtice, 221, High Holborn, near the British Museum. The volumes may be consulted at this address by the public during office hours. The price of this *Index* is 12s. 8d. a year, post free, and we can imagine it will be found of the greatest use to many men in many lands.

Victoria Underground Railway.—The Select Committee of the House of Commons presided over by Sir J. Kennaway, have considered the Edgware-road and Victoria Electric Railway Bill in an enquiry extending over four days. Several witnesses testified to objections to the railway in Grosvenor-gardens. Mr. A. Giles, past-president C.E., thought there was risk to be feared in the process of construction, because the crown of the tunnel would be separated by only 12ft. or 13ft. from the cellars of the houses. Mr. Eustace Balfour, agent for the Duke of Westminster, said this was an elementary scheme and an isolated effort to deal with the question of fluctuating traffic. The Duke of Westminster, acting chiefly on behalf of his lessees, objected to the scheme on the ground that it did not form any part of a broad metropolitan scheme for subterranean traffic. The engineering details did not seem to have been sufficiently thought out, and it would be a great pity if ground should be taken up which would possibly injure the houses in the neighbourhood, unless it formed a portion of a large, broad scheme to benefit London as a whole. Mr. Pembroke Stephens, Q.C., answered for the promoters. The chief objection, however, especially by the London County Council, was that injury would be done to Hyde Park-corner, where it was proposed to erect a station in the roadway. The committee, after careful consideration, decided that the preamble of the Bill was not proved, and the scheme is therefore rejected.

Electricity in Art and Literature.—Electricity in other forms than the telegraph is now made part of plot and scene in modern novels. Electric light also is taking its place in art—the artistic light long adopted by artists begins to be seen in their pictures. In novels, Justin McCarthy's story of "The Dictator," now running in the young and evergreen *Westminster Gazette*, makes point of the electric light in Sir Rupert's where the explosion occurs. The glass globes are shattered, the light goes out, but the engineer-in-charge comes early on the scene to put matters right. Electrical engineers are getting into novels—in small parts as yet. Soon they will take the place of the wonted canal-building hero. Dr. Conan Doyle tried his hand at introducing electricity in a short story a while ago, but if the truth be told, he made a sad hash of Ohm's law and electrostatics: the advertisers' tag, "Electricity is life," seems to have been his idea—an extra strong shock made the villain deathproof. We know some—well, not villains, but engineers—who on this count might live to the millennium. Frank Stockton, we hear, is writing an electric novel in the *Electric Spark*, a paper that aims at being more popular and amusing even than the *Lightning* of this side the water. Edison's novel has not "come off," as the racing-men say—he has found his time too much taken up in discovering how to generate electricity from heat. In art, we see electric light shines in Mr. Solomon's picture which is to adorn the Royal Academy this year. A very high-class dinner party is the subject of the picture, and a striking feature is its illumination by electric light. Even Shakespeare is now dragged in to point a moral on transmission of power. The motto of Prof. Forbes, of Niagara, at the recent convention, was understood to be: "Oh, what a fall was there, my countrymen!" This may be badinage, but it illustrates the signs of the times—the influence of electricity is everywhere.

Electric Supply by Gas Companies.—The following suggestive letter from Mr. S. Carpenter, of the Dorking Gasworks, appears in the *Journal of Gas Lighting*: "As the demand for electricity for various uses is increasing, it becomes a debatable point as to whether it would not be wise and expedient for gas companies to supply this demand. In the present state of the law regulating gas undertakings, gas companies cannot use the capital raised by their gas undertaking for any other purpose than for the manufacture and sale of gas. Why gas companies should be debarred from selling light in any other form when demanded by their consumers is a question which should receive the consideration of every person connected with gas undertakings, and it is for the purpose of drawing attention to this matter that I now address you. I have been approached—and no doubt other managers have been—by gas consumers who say: 'We should like to have the electric light; and we think the gas company can supply it as cheaply as anyone. Why do you not supply it?' I think there can only be one answer to this, and that is the gas company should supply the want. I do not intend to discuss the *pros* and *cons.* of electric lighting, but I think most of us will agree that it has come to stay, and profits can be made from the supply of electricity if a proper charge be made therefor. I am of opinion that if the Board of Trade were approached by a representative body such as the Gas Institute or the Institution of Gas Engineers, who would have no difficulty in proving that it would be for the mutual benefit of consumer and shareholder, they would be disposed to reconsider the matter as to separate capital. Their policy has been in the past that of protecting the gas shareholders against any loss that might occur in the electric-light department, should the two be worked together; but I think directors may be credited with at least as much ability in the management of the electric lighting department as they have previously exercised in the gas department." This indicates a stirring of the interests, and a tardy recognition that electric light has really come to fight gas in the supply of illumination. We fancy the suggestion is too late, and that competition, *not coalition, is the order* of the day at the Board of Trade.

Arc Lamps.—The brilliance of the electric arc for street-lighting is becoming popular, and soon no town of any claim to front-rank size will be without its public arc lamps. Opportunely, therefore, Messrs. Crompton and Co., ever ready to provide for a demand, and, if necessary, create one, are issuing a new price-list of arc lamps and accessories. The old type DDo, if not exactly like the "dodo," is rapidly being hard pressed by a newer and steadier rival. The well-known form of Crompton arc lamp has long been a favourite, and for situations where the lamps are exposed to rough usage and weather has been found very satisfactory. But the establishment of central stations has caused a demand for arc lamps for shops and street-lighting, where a lighter and more compact lamp is desirable—one that shall also burn with the extreme of steadiness. A new lamp under the Crompton-Pochin patents has been designed, and manufacturing arrangements are being made for executing orders. Careful tests, extending over long periods of time, have been made with recording instruments, and these have shown that both the volts and the watts in the arc in this lamp remain constant within 2 or 3 per cent., and the light is therefore correspondingly steady; the consumption of carbons is also reduced on account of this steadiness. With these lamps, burning 14mm. carbons above and 9mm. carbons below, a light of 1,200 c.p., measured at an angle of 30deg. from the horizontal line, has been obtained in practice with 6·9 amperes and 39 volts, or 270 watts. The terminals are so arranged that the act of opening to inspect the lamp cuts it completely out of circuit, and the body of the lamp is insulated, making it very safe to handle. Two patterns are made—single and double carbon. Both these are focussing lamps, the arc maintaining a constant position in the globe. The lamps have no springs, and require no adjustment on erection. The lamps are made for photographic purposes, and are wound for alternate currents. Arc lamp sundries are tabled, priced, and codified with code words that cannot be forgotten, from "timberhead" to "tinworms," whatever these may be—perhaps the springs which are now taken out of the Crompton-Pochin lamps. It is a very necessary catalogue for public authorities, contractors, shippers, and engineers.

Train-Lighting in Ireland.—The Irish Great Northern Railway has done well in introducing the electric light in its railway carriages. On Saturday a public trial view was given of the lighting, and a number of gentlemen were afforded an opportunity of testing the efficiency of the electric installation on the train as well as the system of heating the carriages by steam. A new train of five carriages—one first-class and saloon, with two lavatories, one second-class, and two third-class, with guard's van—left Dublin for a run to Drogheda and back, the electric light being fully on during the double journey. Mr. Robertson, general manager, and Mr. T. Wallace, superintendent of the line, with Mr. Hornsby, of the Midland Great Western Company, travelled by the train, while the general arrangements were carried out under the supervision of Mr. J. W. Woods, locomotive superintendent, and Mr. Maurice Pitman, of Messrs. William Curtis and Sons, Middle Abbey-street, by whom the installation and the heating arrangements were executed. The trial was in every sense a complete success, and the Great Northern Company are to be congratulated on their public spirit and enterprise. A combined dynamo and accumulator system is used. The installation for the five carriages consists of 65 incandescent lamps of 5 c.p. and 6 c.p., so that it can be seen a very good light is obtained. The current is supplied from accumulators in the guard's van, these accumulators being capable of supplying the whole of the train for three hours without using the dynamo. The dynamo is also fixed in the guard's van, and is driven off the axle of that carriage. While the train remains at a station the lamps are fed from the accumulators only, but as soon as the carriages assume a speed of 30 to 35 miles an hour the dynamo is automatically cut into the circuit, charging the accumulators, and at the same time supplying light to the train. There is a battery of 25 accumulators in the guard's van. In each of the second and third class carriages there are two 6-c.p. incandescent lamps, placed in the roof and provided with suitable reflectors. In the first-class there are four five-candle incandescent lamps with reflectors; these are fixed under the hat-racks, which is found a convenient arrangement for reading purposes. Three of these lamps in each carriage have separate switches, enabling passengers desirous of sleeping to turn them off, but the fourth one cannot be interfered with, and remains illuminated during the journey or until turned off at the guard's van. It may be mentioned that while all the fittings were done by Messrs. Curtis and Sons, the dynamo was supplied by the General Electric Traction Company, of London, and was specially made for the Great Northern Railway Company.

Electrical Preparation of Uranium. — In the course of a note presented on this subject by M. Moissan to the Paris Academie des Sciences, he mentions that the use of an electric furnace allows of the rapid preparation of refractory metals which were formerly difficult to obtain. To accomplish this object, it is only necessary to place in the cavity of a lime furnace a certain quantity of magnesia, which is absolutely stable at the temperature of the arc, and to place above a crucible of retort carbon containing the mixture of carbon and of oxide to be reduced. When the metal is volatile, a current of hydrogen is passed through the furnace, and the metallic vapours are condensed in a cool receiver. In this manner calcium, barium, and strontium are prepared. If the metal is not sensibly volatile, it remains at the bottom of the crucible in the form of an ingot. This is the case with uranium. M. Peligot has already obtained, but with great difficulty, metallic uranium in small quantities by reducing the oxide of uranium by an alkaline metal. At ordinary temperatures the different oxides of uranium cannot be reduced by carbon, but such is not the case with, as already mentioned, the high temperatures of the electric furnace. The metal is obtained by calcining, in a porcelain cup, nitrate of uranium, which can be prepared in great purity. There then remains a reddish mixture of sesquioxide of uranium and of green oxide, U_3O_4. To this mixture is added a little powdered carbon, and the whole is strongly compressed in a carbon crucible. By submitting this mixture in an electric furnace to the action of an arc produced by a current of 450 amperes at 60 volts, the reduction is completely effected in a few moments. After having cooled the crucible, a metallic ingot, of brilliant fracture and great hardness, is taken from the furnace. This, when thrown upon the porcelain, or when the fragments are agitated in a glass bottle, gives brilliant sparks by the combustion of small portions of the ore. There is thus produced, although with much greater brilliancy, a phenomenon analogous to the combustion of particles of iron which take fire by simple friction in the air. The percentage of uranium prepared in this manner is tolerably large. One experiment, lasting 12 minutes, yielded from 200 to 220 grammes. The 600 grammes which M. Moissan showed to those present at the meeting had been prepared on three occasions, each reduction only occupying about 10 minutes. A qualitative analysis showed that the specimens consisted only of uranium and carbon. Tests of various samples gave the following percentages: (1) uranium 86·25, carbon 13·50; (2) 89·46 and 11·03; (3) 89·10 and 10·24; and (4) 95·70 and 5·02 respectively. These carbides of uranium decomposed water slowly at ordinary temperatures, and their fusing point is much higher than that of platinum. Thus, by direct reduction from oxides of uranium at high temperature real cast uranium can be produced.

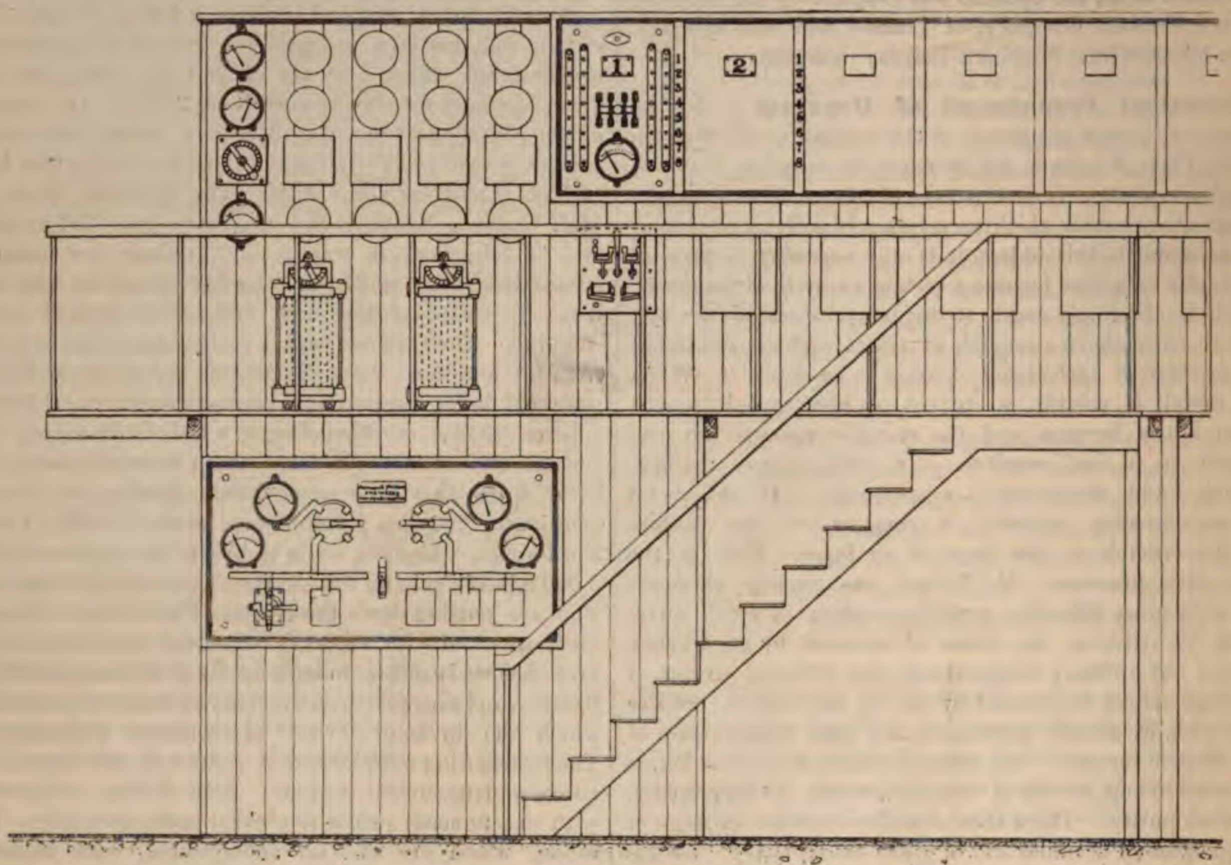
Electric Lighting of Geneva.—A concession was granted in 1887 by the municipal authorities of Geneva to the Société d'Appareillage Electrique for the establishment of a central station for the supply of light to private consumers. In 1891 this company acquired the works of MM. Cuenod, Sautter, and Co., of Geneva, and has since then been known as the Compagnie de l'Industrie Electrique. The station is arranged on the continuous-current system, with distribution on the three-wire system. The laying of the cables and installation of the generating plant took place in 1887, and from the end of that year the station has been in operation since without any interruption, and the service has steadily developed. The number of lamps supplied is about 8,400 of 15 c.p. The station contains five independent groups of generating machines, of which four are of 200 h.p. each, and the other, specially for day service, is of 25 h.p. On account of the distribution on the three-wire system, each group comprises two similar dynamos; these two are driven by a turbine placed between them. The dynamos, made by MM. Cuenod, Sautter, and Co., each give 600 amperes at 110 volts, and it was owing to their low angular speed that they could be coupled direct to the turbines by means of the now well-known Raffard elastic coupling. The turbines receive their water under pressure from the municipal water-distributing service of the Rhone, the water being received at a constant pressure of 13 atmospheres (195lb.), corresponding to a fall of 130 metres. The turbines run at 350 revolutions, and notwithstanding the little space that they occupy they develop, as already mentioned, 200 h.p. These were made by MM. Faesch and Piccard, of Geneva, and who, by-the-bye, constructed the 5,000-h.p. turbines for the Cataract Construction Company, who are putting down the Niagara Falls plant. The turbines are fitted with Piccard's automatic regulators, which keep the speed constant independently of the variations in the lighting, and which act upon the vanes by means of mechanism which the inventor terms "Servomoteur hydraulique." The distributing switchboard is similar to that adopted in all continuous-current stations. Each dynamo is provided with an automatic switch to prevent short-circuiting. The cables, which are all laid underground, were made by Messrs. Siemens and Halske, of Berlin, there being 11 feeders, which are calculated for a loss of 5 per cent., and the difference in pressure in the different parts of the town never exceeds 1·5 volts. Current is charged to consumers either by energy meters or by horal meters, the former being of the Aron and Batault and Brillié type, and the latter of the company's own manufacture. In view of the increasing demand for light, the company decided to extend its sphere of operations, and accordingly a second station, this time on the alternating-current system, was built. This serves the external portions of the town, the generating E.M.F. being 2,400 volts, which, by means of transformers, is reduced to 110 volts and distributed on the three-wire system. This station contains at present one alternator of 50 h.p. and two of 200 h.p., each of which is driven by a high-pressure turbine. The exciters are mounted on the shafts of the generators. The cables are concentric, are laid underground, and form two circuits capable of dealing with future extensions in the demand for light. No less than 21 transformer stations or boxes are in use.

PADDINGTON CENTRAL STATION.

(Concluded from page 287.)

The working load on each of the alternators is about 100 amperes 1,050 volts, the speed being 600 revolutions per minute. They are each driven by eight ropes 1⅞in. diameter from the engine flywheels, which are 14ft. in diameter, running at 100 revolutions per minute. The armature is 42in. diameter, having an iron core 9in. deep, wound with 20 coils joined in two parallels, and it revolves between two rings of field magnets, there being 20 poles in each ring, thus giving at 600 revolutions per minute a frequency of 100 per second. As will be seen from the illustration in our issue of the 10th inst., the yoke rings are provided with racking gear, and are so designed that the top half may be lifted off when it is necessary to remove the armature. It is not proposed to run the machines in parallel, but any number of circuits may be run from one machine. As regards excitation of the alternators, there is a board for this purpose, so arranged that either one of the two exciters or both together may be used. One exciter, however, is capable of exciting the five alternators.

The main from every dynamo passes first to a double-pole main cut-out magnetic switch, which is got to act when any short circuit causes extra current to flow in any dynamo circuit, and in such case the circuit would be immediately broken, saving the mains and dynamo from burning. Above this first switch is a double-break double-pole switch, which can be pulled up or down, connecting into either of two alternative circuits as desired. Each of these circuit switches is connected to two upright bars, through which, by plugs, connection can be made to any of the dynamos. All the circuit-plugs are provided with screw threads for the back contact, the front fit being taper, thus ensuring a perfect contact, not liable to work loose under any circumstances. There are two sets of these upright bar connections for every circuit, and the spare set can be cut in by simple movement of the lever handle should anything go wrong with any dynamo, or, as is more usual, when the load growing heavier the circuits require to be subdivided over several dynamos, or *vice versâ*. Above the switches are Hartmann and Braun ammeters and voltmeters, and each circuit is surmounted by a small transformer, which reduces its current to 100 volts, on which a test lamp is kept burning. Below all this, under the gallery, near the ground, are the double-pole cut-outs, subdividing the high-pressure circuits before they go out into the mains, each separate exterior circuit being safeguarded by a double fuse. The first fuse is of fusible soft wire, passing over a slate partition to prevent arcing. Still further to reduce any possibility of arcing, a second fuse of high-resistance German-silver wire of considerable length is placed on the same circuits. Switch lever handles enable any single circuit to be cut out for repair or testing with the greatest ease.



Switchboard at Paddington Central Station.

The switching arrangements are very perfect and convenient. The main switchboard is manipulated from a gallery at which an attendant is stationed during working hours. The exciter switchboard is below the gallery, and from this the current can be switched into any of the large alternators. The resistances are placed above, on the gallery, and regulating resistance switches are here under the hand of the attendant to vary either the fields of the exciter, or the current from the exciter to the fields of any alternator. The main switchboard is a magnificent piece of workmanship, mounted on marble, and fitted with every convenience for easy switching or changing of circuits. Arrangements are made for eight dynamos and eleven main circuits; not all of these are yet in use. There are five dynamos ready for running, and at present there are two circuits of 60 amperes each, so that one dynamo is at present sufficient, or two at most at the heaviest time. Two out of the eleven main circuits are kept for trunk mains to connect with the company's other stations in case of accident. A special Post Office A B C telegraph is run to the other stations for ease of communication.

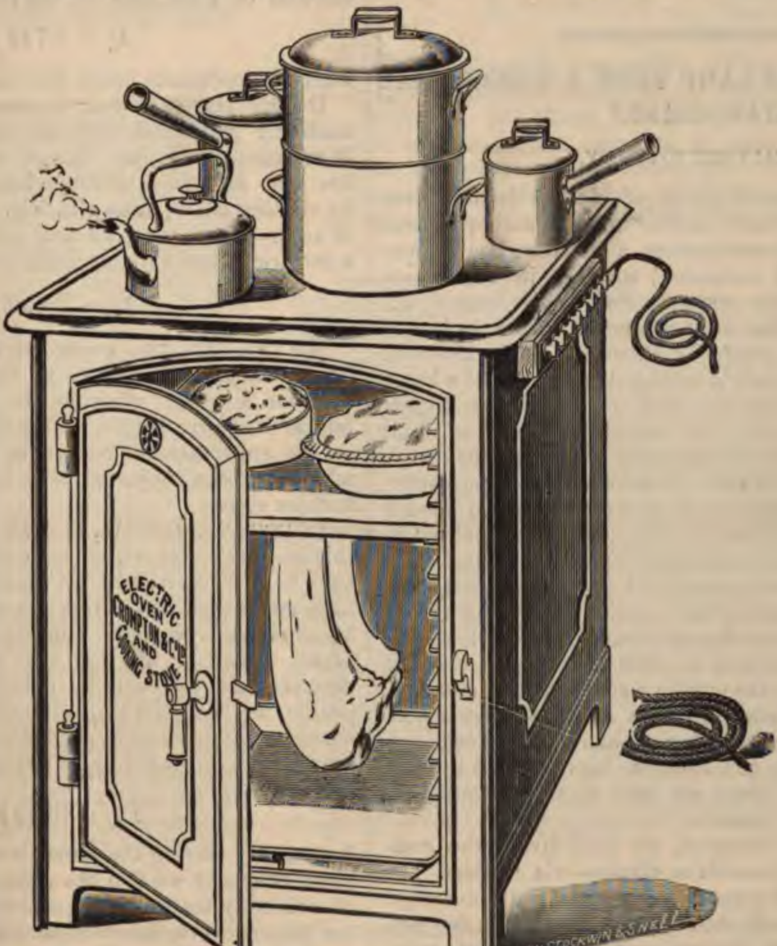
The general arrangement of the switchboards and cables is due to the engineer of the Metropolitan Company, Mr. F. Bailey. As will be seen from our illustration, the main switchboard is erected somewhat above the floor level, with a platform in front, which is reached by a short staircase—the attendant can therefore get a good view over the whole of the engine and dynamo room.

No public electrical ceremony is now complete without an exhibit of electrical cooking, and the inspection of the Paddington station was no exception to this rule. Messrs.

mpton had a goodly array of electric frying-pans,
, tea-kettles, curling-tongs, and smoothing-irons,
n going order, for the satisfaction of the Vestry.
akes, poached eggs, and even chops were handed
d; cups of coffee made by electricity were at the
ce of everyone, attended by delicate puff-cakes made
he deft-handed lady cooks, and baked in Crompton's
ric oven. Cigar-lighters, foot-warmers, conservatory-
ers, and all conceivable heating arrangements were on
. An exhibit of electric cookery and heating will be
permanently at the station. It is whispered that
ngements are likely to be made by certain companies
supply of electricity in the daytime for heating pur-
s from separate meters at something like 4d. per
, and there is little doubt such arrangements would
both customer and company. If this example be
set in the City, the station engineers of Paddington and other districts will promptly follow, and thus help to fill up the load in the day hours. The ordinary price for the current for electric lighting will be 7½d. per unit.

A point that should be mentioned before we leave the description of the new station is the street-lighting. No arrangements have been yet made for arc lighting in the streets, and this is a pity from several points of view. The public do not get the benefit in the streets of the latest and most brilliant lighting, and, on the other hand, the company do not get the advertisement that they should have for their supply. With arc lights down the principal streets everyone knows electric light is laid on, consider the desirability of having it themselves, and very soon send in their orders. This has been especially found the case in St. Pancras, where the whole available supply has been

Electric Kettles.


ELECTRIC OVEN CROMPTON & Co. AND COOKING STOVE
QUEEN STOCKWIN & SNELL

Electric Oven.

quickly taken up. The same may be said for the City. Then why is it not done by the Metropolitan Company? The answer has been that it is too expensive. The company maintain that it would not pay to run arc lamps under £40 a year. This, we think, is a mistake from tactical and financial points of view. It is not as if the pipes had to be run specially in Paddington. The pipes are already laid. Forty arc lamps can be run on a No. 10 wire, and several such wires could be run without taking up much room or causing very much trouble or expense. The establishment of one or two arc machines, when the station is running and steam is kept up, is not such a great additional cost—there would be simply the extra fuel, the carbons, and trimmers' time, with interest and depreciation on the extra machinery. It would be more nearly the case, judging from the experience at St. Pancras, that the charge of £26 or £30 a year per arc would give a profit of £5 or so per lamp, besides giving the public a splendid light and the company a magnificent advertisement—advantages which it would be worth while taking a little trouble of amicable arrangement between engineers and Vestry to secure. This may come in time, and we hope it will come soon.

We have here touched upon the various points in a central electric station that is extremely interesting as being the very latest in alternate-current practice in England. The station is roomy, clean, exceedingly well arranged and convenient, comprising the highest class of machinery, and is one that is well worth a visit from engineers or members of corporations who are interested in the establishment of central electric supply. It is especially to be recommended to the notice of those benighted individuals who still seem to believe that electricity is in its infancy. The answer to this fatuous saying should be: "Go to Paddington."

THE INCANDESCENT LAMP FROM A COMMERCIAL STANDPOINT.[*]

BY CALVERT TOWNLEY.

All modern commercial forms of electric incandescent lamps in this country are similar in that each produces light by heating to incandescence a hard carbon burner of comparatively high resistance, enclosed in a glass receiver from which the oxygen has been largely exhausted. We know that after a time a burner so heated gradually depreciates, either by disintegration, oxidation, or some other cause, and is finally destroyed. We know that, of two similar burners, that raised to the higher temperature will require less energy per unit of light produced, but that its depreciation will also be more rapid and its destruction take place sooner. Consequently, in determining the temperature at which a carbon should be burned to secure the best economy, we are influenced to use a high temperature on account of the first condition, and a low temperature on account of the second condition.

There may be said to be other causes, due to differences in the design and construction of various lamps, which will affect the length of the lives of their burners, but it seems fair to assume that, by the employment of proper methods, these causes may be eliminated in so far as they hasten depreciation in one carbon more than in another, and, therefore, in discussing the relation between the life and efficiency of different lamps, we may consider simply the characteristics of their burners.

For convenience in discussion, we may divide the commercial lamp burners into three classes—viz.: First. The untreated or natural burners used in the Edison lamps. Second. The treated or flashed burners used in the Sawyer-Man, Thomson-Houston, Beacon, and a number of other lamps. Third. What we may call the super-treated burners used in the new Westinghouse stopper lamps.

In all published tests of the life of burners there is shown to be a definite relation existing between the life of a carbon and the temperature at which it is burned, this relation remaining fixed for carbons of the same kind, and varying only for carbons of different kinds. If we formulate this relation, it will assist us to determine what temperature of any kind of carbon may be expected to yield the best commercial results; that is to say, how much money it is desirable to spend on the maintenance of the carbon, and how much on the energy to heat it. The temperature of a burner is difficult of measurement. It will, therefore, be simpler, and quite as satisfactory, if we consider the relation between life and energy consumed, expressing the latter in watts.

By a series of experiments extending over several years, and covering tests of many thousand lamps, Mr. Frank Stuart Smith has found the relation between the life and efficiency of the Sawyer-Man carbons, and through his courtesy I am permitted to give you the results. The relation is expressed by the Curve A, illustrated herewith in Fig. 1, where the axis of Y represents hours life and the axis of X watts per each candle of light produced. As this relation is confirmed by so many tests made at different times, upon lamps of different efficiencies, and under the care of different assistants, there can be no reasonable doubt as to its correctness. From a limited number of experiments made on many other lamps having treated carbons, it is indicated, as might be expected, that the relation between the lives and efficiencies of their burners follow the same general law. Therefore, if we assume that these lamps are constructed with the same detailed attention to design and manufacture, we may then also assume that their curves will not vary materially from that of the Sawyer-Man carbon.

The exact mathematical expression corresponding to this curve is somewhat complicated, but, as we are considering the question from a purely commercial standpoint, we may consider the curve between commercial limits, in which case we can express the relation within one-half of 1 per cent. by the formula

$$L_{,} = 3{\cdot}742\, E_{,}^{5{\cdot}73} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where L represents hours lite, and E watts per candle.

During the past year a great many tests have been made by Mr. Smith with the super-treated carbons of the Westinghouse stopper lamps, and the relation between life and efficiency thereby found to exist is illustrated by another curve, shown B, Fig. 1. With the same degree of accuracy as above, we may represent this curve between commercial limits by the equation

$$L_{,,} = 5{\cdot}44\, E_{,,}^{5{\cdot}684} . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We note that this curve corresponds very closely in its general form to the curve of the treated burners, except that for a given efficiency the life of the super-treated burner is always longer. This is as it should be, inasmuch as the super-treated burner is, in fact, a treated burner which has been subjected to an additional process to render it more stable.

In 1888 Mr. John W. Howell presented a paper before this association, in which he exhibited a curve stated to have been constructed from the results of a large number of tests made with the Edison or untreated burners. I have taken the liberty of reproducing a part of this curve in this paper, shown C, Fig. 1, but using a different scale of measurement. It will be noted that this curve is very similar to the curve of the treated and super-treated burners; and, considered between the same commercial limits, we can express it with equal accuracy by the formula

$$L_{,,,} = 1{\cdot}052\, E_{,,,}^{6{\cdot}453} . \quad . \quad . \quad . \quad . \quad (3)$$

$L_{,,,}$ and $E_{,,,}$ having the same significance as before. For a given efficiency we find the corresponding life of any class of carbon by tracing a perpendicular line until it intersects the proper curve, the corresponding life being found directly opposite the point of intersection horizontally. Thus, for an efficiency of 2·5 watts, we find the life of the untreated burner to be 400 hours, of the treated burner 713 hours and of the super-treated burner 962 hours.

It is important to remember that these curves represen the results of laboratory tests, in which the E.M.F. is kept more nearly constant than is ordinarily possible under the conditions of central-station lighting. Therefore, in order to obtain an expression which will represent cial conditions, we must introduce the element of le E.M.F. In Fig. 2, I illustrate a curve verified by us and exhaustive tests by Mr. Frank Stuart Smith, the relation between total energy consumed and t emitted. This relation is such that a line drawn y point of the curve to O (as A O) equals the tangent

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[*] *From the Electrical World,* New York,

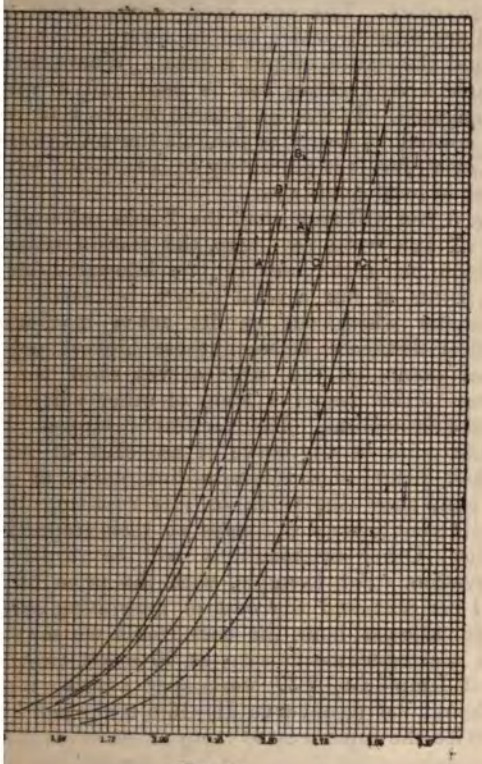


FIG. 1.

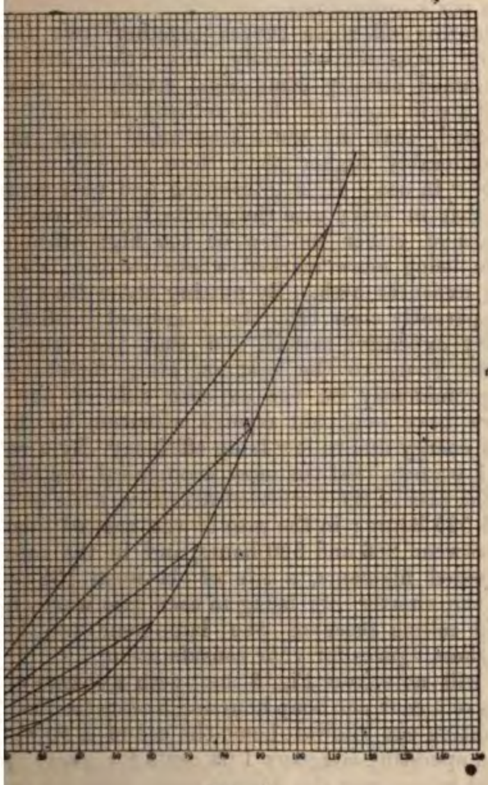


FIG. 2.

ngle made by such line with the axis of X. It is nted by the equation

$$I = \frac{W^2}{\sqrt{R^2 - W^2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

equals the total illuminating power expressed in and W equals watts, R being a constant which s for its value on the size and efficiency of the lamp. fact, the radius of the circle to which our tangent ed. While the position of this curve varies with different lamps, the relation between the watts consumed and the light emitted remains unchanged through all tests. We know that the resistance of a heated filament will remain practically constant through the comparatively small variations in voltage to which a commercial lamp is subjected. Therefore, if we let p equal the per cent. variation in E.M.F., we may write from our fundamental electrical equation $(1+p)\,C = (1+p)\,\frac{e}{r}$, whence

$$W_{,} = W\,(1+p)^2.$$

By a combination of this equation with formula (4), we get the expression $\left(\text{since } \frac{W}{I} = E\right)$.

$$E_{,} = \frac{\sqrt{E^2 + 1 - (1+p)^4}}{(1+p)^2}\ ,$$

where p equals per cent. variation in E.M.F. due to commercial conditions. Substituting this value of E, therefore, in equation (1), we get the expression for the commercial curve of the treated filament—

$$L_{,} = 3{\cdot}742\,\frac{[E_{,}^2 + 1 - (1+p)^4]^{2{\cdot}865}}{(1+p)^{11{\cdot}46}}.$$

By substituting the same value in equation (2), we get the expression for the commercial curve of the super-treated filament—

$$L_{,,} = 5{\cdot}44\,\frac{[E_{,,}^2 + 1 - (1+p)^4]^{2.842}}{(1+p)^{11{\cdot}368}}.$$

Again, by substituting in equation (3) we get the expression for the commercial curve of the untreated filament—

$$L_{,,,} = 1{\cdot}052\,\frac{[E_{,,,}^2 + 1 - (1+p)^4]^{3{\cdot}226}}{(1+p)^{12{\cdot}906}}.$$

It is, of course, impossible, within the limits of this paper, to attempt to express all conditions; but by a comparison of laboratory and central-station records a fair average assumption seems to be that, with proper attention to regulation, the commercial variation is equivalent to a constant excess voltage of 3 per cent. I have taken this as a basis, and constructed commercial curves for the treated, the super-treated, and untreated filaments, which are shown as dotted lines in Fig. 1 and designated as A, B, and C respectively. It now becomes possible to calculate accurately the efficiency at which any class of lamps should be burned in order that they may yield the best economy.

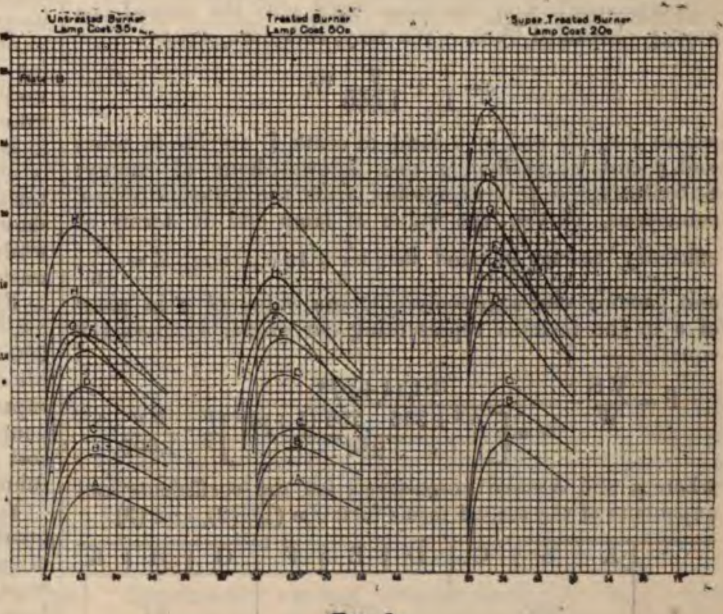


FIG. 3.

It is important to note the great effect that a comparatively small rise in E.M.F. has on the life of a lamp. Any neglect to maintain the best possible regulation, therefore, will result in an increased bill for lamp renewals entirely out of proportion to the variation in voltage itself.

The condition of the incandescent lighting business throughout the country is undeniably prosperous. Everywhere central-station companies are wiring additional lights or preparing to increase the capacity of their machinery. We will not be far wrong, therefore, if we assume, in the consideration of our subject, that the central-station company has a market for all the lamp hours it can furnish during a certain portion of the day's run. With this assumption, let us formulate an expression for the profit in incandescent lighting, then we may determine what conditions will give this profit a maximum value. In the consideration of this matter I have taken as the unit of value one 16-candle lamp hour, assuming that what the public want is light, and that, other things being equal, they do not care whether much or little energy be expended to produce it. Therefore, whenever we can increase the efficiency of our lamp, we not only reduce the cost of the energy required to burn it, but also increase the lamp capacity of our station, lines, converters, etc., by a proportional amount. Owing to the fact that the various meters in use measure, not light, but energy in one form or another, when we make our unit the lamp hour and afterward increase the efficiency of our lamp, we must also increase our charge per unit of energy in order to maintain the same standard of price. Were any unit of energy to be taken as the unit of value, the receipts from a given output would become fixed, and the best lamp at once the most inefficient and longest lived. Political economy is clear, however, that to reduce the price of any commodity increases the demand for it, and in competition with other illuminants the only proper standard can be that of illuminating power. It is nearly always possible to change existing rates whenever it is proper to do so.

With our unit of value illuminating power, therefore, our profit will obviously be the difference between the cost and selling price of a lamp hour multiplied by the number of lamp hours sold. We may therefore write the expression—

$$P = (v - c)\frac{S}{W},$$

where P equals profit, v selling price, c cost of lamp hour, S output of station in watt-hours for the time for which our profit is estimated, and W watts required per lamp. Again, the cost of producing one lamp hour is clearly the proportionate cost of the lamp itself, plus the cost of the energy consumed by it. We may, therefore, write—

$$c = \frac{1}{L} + \frac{g}{1{,}000} W,$$

where 1 equals cost of a lamp in cents, L its life in hours and g cost of producing one kilowatt-hour of energy. Substituting in this expression, from the formula of our commercial curves, the value of lamp life in terms of efficiency, bearing in mind that for a 16-c.p. lamp $E = \frac{W}{16}$, and putting our expression for the value of c in place of c in the formula representing our profit, we have the equation—

$$P = \frac{VS}{W} - \frac{S1\,(1+p)^{2b}}{W\,a\left[\frac{W^2 + 256 - 256\,(1+p)^4}{256}\right]^{\frac{b}{2}}} - \frac{S\,g}{1{,}000}$$

where a and b stand respectively for the coefficients and exponents of the second terms formulæ (1), (2), and (3).

	A	B	C	D	E	F	G	H	K
v	·005			·0075			·01		
g	5	3	2	5	3	2	8	6	2

Curves similarly lettered are constructed with similar values of g and v, the differences in their position and form being caused partially by the different costs of the lamps and partially by the different relations between the lives and efficiencies of the several classes of carbons.

I illustrate in Fig. 3 a number of curves constructed for the untreated, the treated, and the super-treated filaments, *using this* formula. I have taken the original cost of the lamps at, respectively, 35, 50, and 20 cents, the selling price of a lamp hour at, respectively, ·5, ·75 and 1 cent, and the cost of producing current at, respectively, 2, 3, 5, and 8 cents per kilowatt-hour. By the courtesy of a considerable number of central-station managers, who have furnished data concerning their respective plants, the average cost of this energy appears to vary between three and seven cents. The only cases where seven cents is exceeded are those in which fuel is a very expensive commodity and the station output is small. Where three cents is too high a very cheap fuel is used and a very large station operated. In assuming these values, I believe that we have covered as nearly as possible the conditions which actually exist, but it is quite easy to adapt our expression to any set of local conditions.

In Fig. 3 you will note that the Y axis represents cents and the X axis watts per lamp, the station output estimated upon being the unit of one kilowatt-hour. The highest points of our several curves represent the conditions under which our profits are a maximum, and the vertical distances between these highest points and any other points on the same curves show the loss in profit due to the use of a lamp of other efficiency than the most economical. The vertical distances between the highest point of any curve of one class of lamp and the highest point of a corresponding curve of another class of lamp show the profit or loss resulting from the use of different classes of lamps at their respective best efficiencies. Other combinations will be readily noted by observation. For example, with the price of a lamp hour at 1 per cent, and the cost of generating current six cents per kilowatt-hour, the best result we may expect from the treated-filament lamp at 50 cents each is with a 38-watt lamp—*i.e.*, 2·37 watts per candle, when our profit should be (see curve H) 16·6 cents per kilowatt-hour. With the super-treated lamp at 20 cents, other conditions remaining the same, the best results are obtained with a 30-watt lamp, and our profit should be (see curve H) 22 cents per kilowatt-hour.

Considering all these curves together, two facts are especially prominent—namely, first, that although we have assumed strictly commercial conditions, the profits obtained are in excess of those actually made in practice; and, second, that the most economical lamp efficiencies are considerably higher than those of any commercial lamps now in use. It is interesting and very remarkable to note that in every case the profits fall off very rapidly for lamps of either too low or too high efficiency, the variation being more marked where current is dear and running expenses high. By putting these facts together, it is apparently clear that the long-lived inefficient lamp is a very expensive article, and that too much weight has been given to the cost of lamp renewals, which shows prominently on the expense side of our ledger, while we have not paid enough attention to the great waste of energy due to low lamp efficiency. By a reference to Fig. 1 we note that the most economical conditions call for, in the case of the untreated filaments, a life of between 250 and 525 hours; in the case of the treated filaments, a life of between 286 and 620 hours, and in the case of the super-treated filaments, a life of between 138 and 260 hours; the shorter life being in each case where both the cost and selling price of the lamp-hour are high. I submit these figures for your consideration.

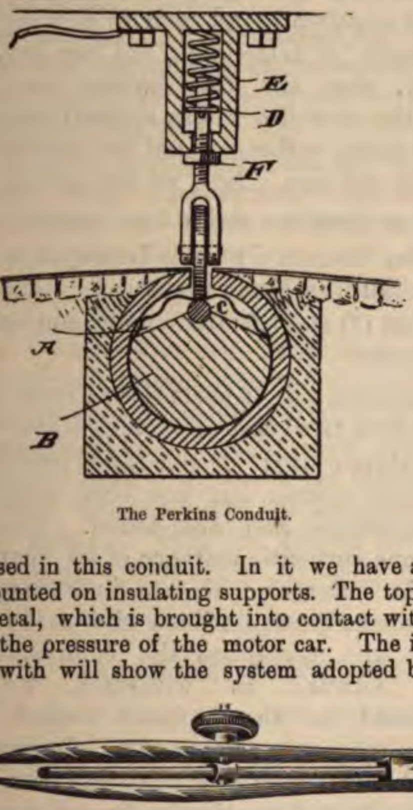
You will note from Fig. 3 that with a charge of three-quarters of a cent per lamp hour and 5 cents for the expense of generating one kilowatt-hour, the use of a 50-watt lamp loses the operating company 1·05 cents for every kilowatt-hour sold when using the 35-cent lamp with the untreated burner; 1·4 cents when using the 50-cent lamp with the treated burner, and 5·2 cents when using the 20-cent lamp with the super-treated burner, as compared with the profits which might be made if these various lamps were used at their respective best efficiences.

It is gratifying to find that the possibility of increased profits carries with it the implied possibility of reduced prices to the public, and, therefore, a great demand for light, and greater success to the companies furnishing same, in competition with other luminants.

I have said nothing in this paper in regard to fall in candle-power, for the reason that, in both the treated and super-treated filaments this fall is roughly proportional to the time the lamp has been burning as compared to its total life; that is to say, if a filament has a life of 1,000 hours at a given efficiency, and during that time its fall in candle-power is A per cent., if this filament is burned at an efficiency which will make its life 500 hours, its fall in candle-power will still be approximately A per cent., so that our commercial results are not appreciably affected. For the untreated filament the fall in candle-power is proportionately larger than in the other two filaments. Therefore, if we are making a comparison of total illuminating power per energy consumed, we must put the untreated filament on a somewhat lower scale than shown in the comparisons I have drawn.

PERKINS CONDUIT.

Mr. F. C. Perkins has designed and patented a new form of conduit for electric traction work. Elasticity is the property utilised in this conduit. In it we have a bare conductor, mounted on insulating supports. The top is formed of sheet metal, which is brought into contact with the conductor by the pressure of the motor car. The illustration given herewith will show the system adopted better than any lengthy description. A represents a metallic tube formed of copper, brass, steel, phosphor bronze, or any suitable material having the requisite elasticity for the purpose, and being proof against the effects of the weather and at the same time a good conductor of electricity. This tube is formed in lengths, and contains an insulating support, B, within it, which may be of wood impregnated with oil or otherwise treated to render it a good insulator, upon which is mounted a bare supply conductor, C. This conductor, C, is referred to herein as a supply conductor, by which is meant either the outgoing or return conductor, or both, of a system of electric supply. If alternating currents be used in the system, the conductor will serve as both outgoing and return according to the direction of the impulse.



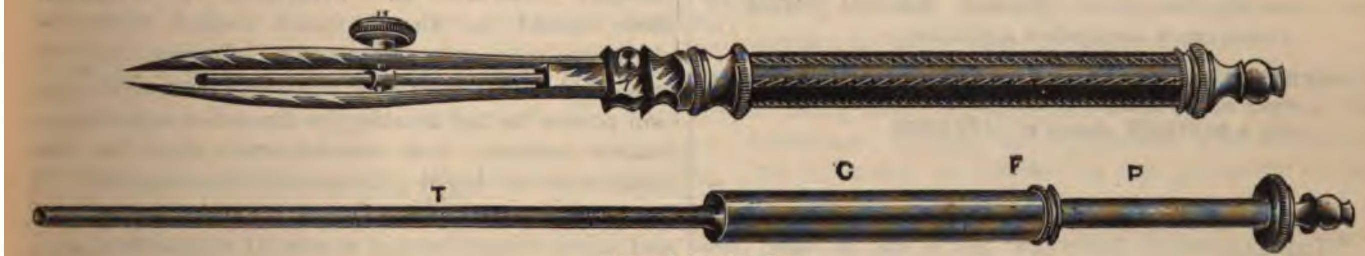
The Perkins Conduit.

The tubular shell may be circular in cross-section, but is preferably provided with a number of corrugations, so as to give it increased flexibility. In its normal position the tube is maintained by its own elasticity out of contact with the conductor, C, and may be held at any suitable distance therefrom, which will, of course, vary with the size of the conduit, increased flexibility being possible as the size of the tube increases.

Upon the car is mounted a presser-foot, which is preferably shod with a wheel at the point where it enters the conduit or comes in contact with the metallic tube, which may be arranged so that the degree of pressure may be controlled by the motor-man. As shown in the drawings, a simple screw adjustment is shown, by which the pressure of this foot may be varied—an elastic spring, D, surrounding a stem which enters a box, E, the tension of which may be varied by adjusting the nut, F. The pressure of the spring should be sufficient to force the top of the metallic tube, A, into contact with the conductor, C. There is a good deal of ingenuity in this design, but practice alone can prove whether there are not several weak points in it which may prove insurmountable.

RESERVOIR DRAWING PEN.

We herewith illustrate a little instrument which should be found very useful in drawing offices. Just as we have had for some time reservoir pens—some of which are good, some of which are otherwise—we have now the application made to a drawing pen. The illustration will show exactly how the apparatus is made. In the first place, we have an ordinary hinged-nib drawing pen, provided with a hollow metal handle, into which fits a cylinder, C, which is shown withdrawn from the handle in the lower illustration. The rod or plunger, P, serves to draw the Indian ink into the cylinder, C, while the tube, T, is provided to carry the ink to between the nibs of the pen; the whole reservoir attachment, as will be seen from the illustration, constituting in reality a miniature hand-pump. To use the pen, you must withdraw the cylinder, C, from the handle (taking hold of the milled gland, F), and fill it with ink by dipping the lower end of the tube, T, into the liquid, and pulling out the plunger, P, to its extreme position. After wiping the tube, insert the whole cylinder (without, of course, disturbing the plunger) into the handle of the pen again. A slight push forward of the plunger, P, then serves to feed the pen with ink; when this is exhausted the plunger is again pushed slightly forward and the pen is again replenished. If it is wished to interrupt the work it is only necessary to blow out the ink remaining between the nibs of the pen; the ink in the cylinder will keep good for days.



Reservoir Drawing Pen.

The value of such an instrument as this is too easily seen to need any further description from us. The only wonder is that such a piece of apparatus has not long ago been upon the market. These pens are supplied by Messrs. Jackson Bros., of 50, Call-lane, Leeds.

Electricity versus Compressed Air.—At a recent meeting of the Wurtemberg District Society of German Engineers, Mr. Cox, of the Maschinenfabrik Esslingen-Cannstatt, gave a comparison of an installation for the transmission of 217 h.p. a distance of about three miles by means of compressed air and electricity. The initial expenditure was respectively £7,500 and £5,500, being £2,000 less in the case of electricity. The guaranteed efficiency was 46 per cent. with compressed air, and 69 per cent. with electricity; and the power received at the secondary station was 100 h.p. and 150 h.p. respectively The compressed-air plant compares very unfavourably.

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THE TELEPHONE QUESTION.

Our contemporary the *Electrical Review* is carrying on this double-barrelled controversy with ability and pertinacity, but it is compelled to admit the relevancy of our criticism in insisting upon the admission that what it calls the Law system includes two systems, one of which has been generally known here as the Mann system. From our point of view it matters not one iota whether we speak of the (1) series-Law system, (2) branch-Law system, or name number two the Mann system. Unless, however, the two systems are rigidly defined, the sweeping condemnation our contemporary makes and still persists in is altogether unwarranted. Upon almost every point those who have followed the discussion will see agreement, but the following sentence is inadmissible: "We regard the Law system (in which we, of course, include the so-called Mann system) as a very interesting example of telephony, but we say, and say distinctly, that the Law system (in which we include the so-called Mann system) *has been established in many exchanges, and has been abandoned.*" The italics are ours. Now we are agreed—

(1) That there is a series-Law system.

(2) That there is a branch-Law system, or, as we prefer to call it, a Mann system.

(3) That (1) and (2) are wholly and entirely distinct systems.

We maintain that it is (1) the series-Law system that has been tried and altogether abandoned.

We maintain that (2) the Mann modification, or branch-Law system, has not been established in many exchanges and abandoned. There is, we believe, one authentic instance of its abandonment, and if the manager who was instrumental in its abandonment, the subscribers who used it, and the directors who controlled the company could be brought forward as witnesses, we imagine there would be an emphatic verdict that the abandonment was an error. Indian experience has also been adduced, but our information points to this relating to the series and not the branch system. Our contemporary must see the importance of keeping these distinctive names. It is not correct to say the Law system has been tried and failed, when there is a mental reservation that the series system alone is meant. However, in its last article, as instanced by the above quotation, our contemporary has thrown aside reservations and boldly includes both systems under the head of failures, and not only so, but proceeds to emphasise its contention by pleading that the so-called Mann system is as old as the telephonic world. Surely, there must be a mental reservation here, in that while the Law Company, we believe, never succeeded in perfecting either "series" or "branch" system, the latter system was successfully applied at Dundee as the Mann system, and is still in existence there, as well as in some twenty other towns in the United Kingdom. It would seem that this fact alone proves that there must be a distinction in the Law and the Mann systems, and shows the necessity of our contemporary sticking so persistently to "branch-Law" instead of Mann, if the Law Company could not make the branch-Law system a success and Mann did make his modification a success.

Our contention, then, is now reduced to this:

The first successful application of the branch system, generally known on this side the Atlantic as the Mann system, was at Dundee. It has never been abandoned. On the contrary, its striking success there directly led to its extension, first to Aberdeen, and subsequently to many other towns.

Its success interested the adviser or advisers of the New Telephone Company, and a trial was given at Manchester. The trial has so far been successful, that we believe the National Telephone Company is considering the question of changing its Manchester system to the Mann system.

The change at Glasgow to the Mann system is in an advanced state, and by the beginning of May should be in full operation.

Our contemporary will recollect that it was owing to somewhat disparaging statements in relation to the New Telephone Company and its adviser that induced us to take part in this controversy, and we claim to have proved that the adviser was not a supporter of the Law system—that is, the series system—but of the Mann modification, and, as we claim, a successful modification. We do not deny that Shaw (or the Law Company) may have indicated in patents, circulars, or otherwise, the branch system, but we deny their success till Mann showed them how to do it at Dundee. He who successfully applies an invention frequently gets recognised by having his name used in connection with it rather than that of the original inventor. Shaw may have invented, or somebody else may have invented or used the branch system, but no one, till Mann appeared on the scene, made it go.

PERSISTENT OPPOSITION.

The Dean of York once, when speaking at Reading before an audience, if we remember rightly, that was not in thorough agreement with him, said he did not believe in any man who took his opinions ready cut and dried from his favourite newspaper, but he thought every man should look carefully at both sides of a question. With regard to the electrical industry there are men who think gas should hide its head and never be heard of again. On the other hand, the men who swear by gas cannot believe any good of electricity. We have never hesitated to say we do not believe in gas for lighting, even if it were not our conviction, which it is. We are bound by politic considerations to point out the advantages of electricity. To gas may be given its due—it may (we, again, do not think it will) hold its own for general heating purposes, but in all probability it will, in the no very distant future, be far more largely used than at present in engines. The dream of large central stations in the midst of our coalfields, generating heating-gas, and using it in engines which are to drive dynamos to promote high-pressure electricity, may not come to reality just yet, but there is something in it. Eminent electrical engineers are beginning to enquire into the possibilities of gas-engines for central-station work; and it is by no means certain that a fair trial will not be given to the system. However, our intention is not to discuss what may or may not be the future of gas, but rather to hint that those who write and speak of gas as the only suitable medium for lighting, and seemingly good for nothing else, have not yet learnt the rudiments of their subject.

At the present time we rather desire to deal with those persistent, consistent, and strenuous opponents of electricity who cannot and will not see any good illuminant outside gas—such men as Dr. Hardman, who has long opposed the action of the Blackpool authorities in the introduction of electricity. Dr. Hardman won't have it at any price. Blackpool, like many other towns, controls the gas supply. Why should the authorities change? Why jeopardise a proved success for the newer illuminant? Dr. Hardman says: "The mainspring of my activity in this matter of electric lighting is the strong desire I feel to interest the ratepayers in the subject, and to arouse them to a full realisation of the importance of this new departure. Either gas is better than electricity, in which case we ought not to have incurred the large debt we have done for electric lighting; or electricity is better than gas, in which case it will completely supersede gas for lighting, and the £40,000 of electric debt will become perhaps £200,000, and £100,000 or more of gas plant will not earn interest or redemption for the debt it represents. Either the money spent on electricity will be a loss, or that spent on gas. The full realisation of the logically inevitable will not be this year nor next, but must come sooner or later. Nothing can be gained for us by the simultaneous employment of both agents. Having sunk our capital in gas, and made ample provision for the complete lighting of the borough with gas, in employing likewise electricity for the same purpose, even if we do not make a positive loss, we are, nevertheless, exactly in the position of that tradesman who doubles his stock to do the same turnover."

Further, our doctor says: "Anyway, every effort is being made by energetic touting to induce the tradesmen to light their premises with electricity, and not a few are yielding to the persistent importunities. In doing so they may or may not be acting wisely, but they are certainly not acting wisely in doing away with their gas fittings. How useful these may become in certain not unfrequent contingencies. I could give you many instances. *Verbum sap.*"

Would it be an impertinent question to ask Dr. Hardman—we presume he is a surgeon—if he retains the surgical appliances of his youthful days, or whether in his own profession he does not relegate the older apparatus to the lumber heap and purchase the newer? Surely, such professional action is on all fours with the shopkeeper who turns out gas for electricity. The latter says his stock suffers from gas, and he therefore prefers the illuminant by the use of which such damage ceases. Is he to be condemned for this? There is no reason why the certainty of electricity should not equal that of gas. Then why retain his gas fittings? The argument against the supercession of gas by electricity is one that can be used against any improvement. It is almost impossible to find in any direction an improvement made which does not necessitate the putting aside of cruder apparatus, though, as we have previously hinted, gasworks might be found useful to provide gas for working the engines driving dynamos. Years ago we suggested that gas companies would do well to adapt their works to this purpose, and undertake the supply of electricity rather than to fight against the inevitable.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE "MANN" SYSTEM.

SIR,—I have taken some interest in the development of telephone work, and can give answers to the questions in your issue of 17th inst. (page 285) respecting the Mann modification of the Law (multiple arc) system (which for convenience I call the Mann system).

1—2. The Glasgow exchange is being fitted with the Mann system.

3. The Mann system has already been adopted with marked success at Dundee, Manchester, Aberdeen, etc.

4. It is the Mann system which the New Telephone Company, through its adviser, Mr. A. R. Bennett, advocates.—Yours, etc., TELEPHONIC.

Glasgow, March 28, 1893.

WHAT IS ELECTRICITY?—IV.

BY SYDNEY F. WALKER.

Generation: (b) By Chemical Action.—In order to understand this part of the subject it will be as well to consider what we mean by chemical action, and what the phenomena we know as chemical action really are. Chemical action we know consists in the combination of certain elements with each other, and often this combination is accompanied by the dissociation of some of the elements from their previous combination with certain other elements. We know, also, that these combinations are frequently accompanied by changes in the physical state of the bodies which enter into the combination. Thus, two gases—oxygen and hydrogen—combine to form the liquid water. A solid (carbon) and a gas (oxygen) combine to form carbonic oxide and carbonic acid gas. A solid, such as iron or zinc, combines with a gas (oxygen) to form another solid—oxide of iron or zinc.

In all cases we have, as we know, a rearrangement of the molecular energy present. Thus, when carbon and oxygen combine, and when hydrogen and oxygen combine, as when coal is burnt in a furnace, molecular energy, in the form of heat, is set free, which may be used to generate steam from water, to warm our houses, etc. So, too, when zinc and oxygen or zinc and chlorine combine to form zinc oxide, or zinc chloride, a certain quantity of molecular energy is set free, which usually appears as heat, but which we know may appear as electrical energy provided the necessary conditions be present. These conditions are present in the galvanic battery.

Perhaps we had better go back a little farther and examine the question how it is that molecular energy is set free when certain bodies enter into combination. The solid, liquid, and gaseous states differ from each other by reason of the quantity of molecular energy in the form of heat that is stored in them. Thus, if heat be applied to a solid body such as lead or zinc, the body gradually expands as it becomes hotter, and at last passes into the liquid state. If, from any cause, the liquid metal loses a portion of its heat, it immediately contracts and at last becomes solid. The molecular vibrations which we know as heat become greater as the temperature rises and as the body passes into the liquid state, and they decrease again as the energy is carried off by surrounding bodies. We know, also, that if we continue the application of heat the lead will pass into vapour, and that it can be reconverted into the liquid or solid state by depriving the vapour of its heat. We know also that any gas may be liquefied if sufficient cold or sufficient pressure be applied to it, and that if we can cause any gas or vapour to pass into the liquid state, molecular energy in the form of heat is set free in the process. From this it follows that any chemical combination which reduces a gas to the solid or liquid form must set free a certain quantity of molecular energy, that which the combination has no further use for, and any combination which causes a liquid to become solid will set free a certain quantity of molecular energy. So, too, any combination which is able to preserve its physical state with the aid of a smaller quantity of molecular energy than the aggregate which is held by the elements which enter into combination, must set free the surplus energy it does not require.

In support of these facts, too, we have the fact that the actinic rays of the spectrum themselves, only a form of molecular vibration, are powerful agents for certain chemical actions. It appears to the writer, therefore, that the well-known principle of the galvanic cell follows directly from a consideration of the principles enunciated above. In the galvanic cell, as we know, we must have two substances, such as zinc and oxygen, or zinc and chlorine, whose combination will set free a certain quantity of molecular energy. We know also that we never get from any galvanic cell the whole of the energy set free by the combination or combustion of the zinc, and we get the smallest return, the lowest efficiency, when this energy is used up within the cell itself. Thus, if we oppose one plate of zinc by another exactly similar, we get no resulting energy that we can make use of. If we oppose the zinc by a metal whose combination with oxygen or chlorine, as the case may be, disengages nearly as much energy as that set free by the combination of the zinc, the galvanic couple is a very poor one. And, as we know, our best results are obtained when the second plate is absolutely inert with regard to the components of the liquid in the cell. We know, too, that the energy we have for use from any galvanic cell depends on the series of chemical actions and reactions which take place within the liquid and on the plates. The resultant energy is, in fact, the algebraical sum of the energies set free and taken up within the cell. But the question at once arises, why does the released energy appear as electricity and not as heat? The answer is that, as in other cases, it does appear as both, only a portion appearing as electricity, and that it appears as electricity merely because the conditions are favourable for that form.

The writer's view is that when you set free a quantity of energy, it may appear as a chemical agent, as light, as heat, as electricity, and in a few cases as sound, according as the conditions are favourable. Apparently, when it meets with certain chemical combinations in the only path open to it, the energy may appear as a chemical agent, splitting up chemical combinations when such are present. It is obvious that a certain chemical combination can only store a certain definite quantity of energy. If more is forced into it, the combination becomes unstable, and must split up. This is the writer's view of electrolysis. A certain combination is present in the liquid through which an electric current is passing, or into which the released energy from the zinc-oxygen combination passes. The liquid holds a certain molecular energy. Its molecules are vibrating at a certain speed. On the entry of the energy carried by the current their molecules vibrate at a higher speed, and the substance is perforce obliged to take another physical state, and hence it splits up into its components. It would have done the same if the energy had been communicated to it in the form of heat, or from the actinic rays of the spectrum, provided the energy had been conveyed to it under the same conditions. We can hardly say yet what the conditions are under which the released energy takes the form of electricity in preference to that of heat, but one condition would appear to be that less resistance shall be offered to molecular vibration when electricity is generated than when heat is; and it would also appear that in many cases the generation of electricity is a preliminary stage to the generation of heat, since the passage of electricity through any body invariably results in the conversion of the electricity into either heat, light, or chemical action.

A closer investigation of this part of the subject will necessarily be made when we come to examine the phenomena we know as conduction and induction. One point that we are able to make with confidence is, that the whole thing appears to turn on the rate and amplitude of the vibrations, just as the varying effects of the different rays of the spectrum do. With a view to clear the ground also, we may, with advantage, examine another part of the question of generation of electricity by means of chemical action—viz., why should the combination of zinc and oxygen give us a larger release of energy than, say, lead and oxygen? The answer that will be made, at first thought, will be, Because zinc has a greater affinity for oxygen, and because the molecular quantities work out so. But this is really only putting the question one place farther back. Why should zinc have a greater affinity for oxygen than lead has? And what do we mean by a greater affinity?

A consideration of the electrolytic bath and of the secondary battery will, the writer believes, furnish us with the answer to this. As we know, by the aid of a current of electricity we are enabled to produce the conditions in an otherwise neutral cell that would rule if the cell contained the usual dissimilar elements, and even to reverse the conditions. Thus, as we know, if we placed a piece of iron in a bath of a salt of copper with a copper plate, unaided by any current from an external source of electricity, it is the iron that would be dissolved, not the copper. Yet by passing a current through the liquid from the copper to the iron, we are able to cause the former to dissolve and the latter to be covered with a deposit of copper, without, if the operation be properly carried out, any loss of metal by the iron plate. In the secondary battery in its simplest form, two lead plates immersed in dilute sulphuric acid, unaided by the current, if the lead plates are exactly alike, no galvanic action will take place, and we can take no current from the couple. But if we allow a current to pass through the cell, we quickly produce conditions similar to those we have in a zinc-carbon cell, though more powerful. What have we done in these cases? We reproduce in the cell, by the aid of the current, the conditions, or similar conditions to those we have present by the simple immersion of the zinc. It appears to the writer, therefore, that zinc, and to a smaller degree iron and other metals, must contain, merely from the fact that they are zinc, iron, etc., metals of particular formation, potential energy, just as the boulder left by a glacier on the summit of a lofty crag does; or better still, just as the mass of vapour present in the form of clouds in the atmosphere does; and that we are able to utilise a portion of this potential energy in the galvanic battery, because the conditions present, the liquid salts, etc., are favourable to the production of the rates and amplitudes of vibrations within which what we know as electric currents must range.

COMPARATIVE TESTS OF HELLESEN AND E.C.C. DRY BATTERY CELLS.*

BY PROF. JAMIESON, M.I.C.E., F.R.S.E., ETC.

Advantages of Dry Cells.—It has been pointed out that dry cells possess certain practical advantages over wet batteries for bell calls, telegraphic, telephonic, medical, and military purposes. For laboratory work, their unbreakableness, compactness, portability, cleanliness, and freedom from accumulating crystals, and the creeping of salts to the outside of the containing vessel, as well as the fact that they are always ready for use, and may be laid on their sides or even upside down, are evident advantages.

In the autumn of 1891 I happened to read an excerpt of a report on an exhaustive and carefully-conducted series of tests by Messrs. Krehbiel, Narr, and Donle, of Munich, on six different kinds of "dry cells." This report seemed to show that the "Hellesen" cell was the best.

I was, therefore, anxious to give the Hellesen dry cells a trial, and obtained at the beginning of last session (October, 1891) about 40 of them from Messrs. Siemens Bros., of London, for use in the electrical engineering laboratory of the Technical College. These cells have been employed since then by the students, principally for copper and insulation resistance and capacity tests, as well as for ringing bells, etc. They have unquestionably proved themselves to be much more convenient for such purposes than the previously used Daniell, Leclanché, Grove, Bunsen, and bichromate cells.

About this time last year I got a few E.C.C. dry cells from Mr. G. Binswanger, managing director of the General Electric Company, London, and, from their general behaviour in the laboratory, I formed the opinion that they were quite as good as those of the Hellesen type. In order, however, to make a set of comparative tests, I procured a couple of quite new Hellesen and E.C.C. cells of about the same weight, and again referred to the Munich report, from which I herewith give the following extract, in order to show that I was comparing the E.C.C. cell with a type of cell which had been proved to be the most efficient of six of the principal dry batteries.

Extract from the Munich Report.—"The most efficient cells, even for circuits of small external resistance, are the Hellesen and the Bender, the former having the advantage of less polarisation and much smaller internal resistance; the Hellesen cell has, however, when exhausted by long working, not quite so much recuperative power as the Bender."

*Total ampere-hours on closed circuit through an external resistance of 50 ohms for 96 hours.**

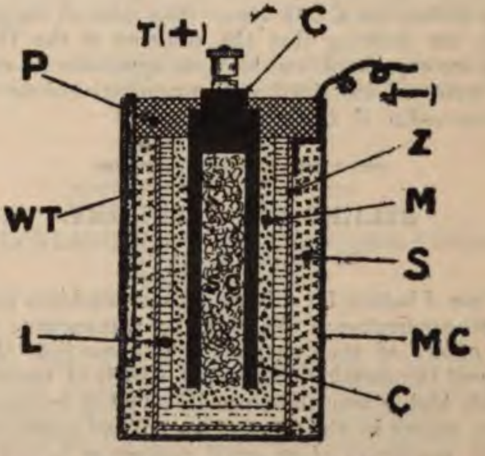
	Ampere-hours.
Hellesen	2·3915
Bender	2·3400
Thor	2·1435
Gassner	1·9374
Jenisch	1·0347
Wolfschmidt	0·5967

*Total ampere-hours on closed circuit through an external resistance of three ohms for 24 hours.**

	Ampere-hours.
Hellesen	5·0792
Bender	4·9898
Thor	3·4552
Gassner	2·6670
Jenisch	1·2236
Wolfschmidt	1·6168

* These cells were evidently of nearly equal dimensions, the Hellesen being of the same size as the present type No. 2.

General Description and Chemical Constituents of the Hellesen and E.C.C. Dry Cells.—The following sectional drawings have been made by one of my laboratory students, Mr. D. Cameron, from sawn sections of the cells, and I am indebted to Dr. Henderson, professor of chemistry in the Technical College, for the chemical analysis:



VERTICAL DIAGONAL CROSS-SECTION.—HELLESEN CELL.

Index to Parts.

T(+)	Terminal positive.	Z	Zinc containing vessel.
C	Carbon (bored hollow).	T(–)	Negative terminal wire.
SC	Silicate cotton.	S	Sawdust packing.
M	Manganese dioxide, etc.	P	Pitch (top covering).
L	Lime and sal-ammoniac, etc.	MC	Millboard case.
		WT	Waste tube.

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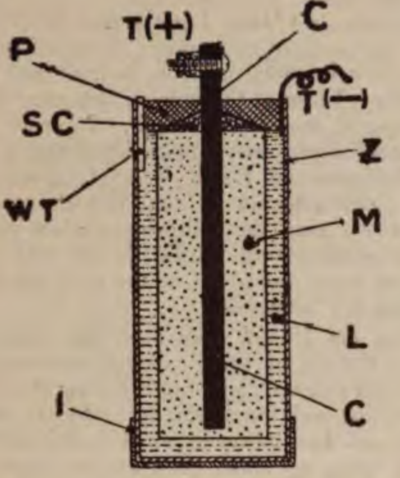
* Paper read before the Glasgow Philosophical Society.

Analysis of Black Paste (M).		
MnO_2	=	25 54
Carbon	=	16·02
SiO_2	=	12·76
MgO	=	12·88
CaO	=	0·96
Fe_2O_3	=	3·46
Moisture and ingredients not determined	=	28·38
		100·00

Analysis of White Paste (L).		
CaO	=	26·18
ZnO	=	6·00
MgO	=	0·57
NH_3	=	2·49
Water and binding material	=	64·82
		100·00



VERTICAL CROSS-SECTION.—E.C.C. CELL.

Index to Parts.

T (+)	Terminal positive.	Z	Zinc containing vessel.
C	Carbon.	T (−)	Negative terminal wire.
SC	Cotton.	P	Pitch (top covering).
M	Manganese dioxide, etc.	I	Insulating base.
L	Lime and sal-ammoniac, etc.	WT	Waste tube.*

* This short glass tube should have been drawn with its lower end terminating in the cotton at S C. These tubes in both cells are evidently to carry off any waste gas.

Analysis of Black Paste (M).		
MnO_2	=	7 57
Carbon	=	47·26
MgO	=	7·20
CaO	=	1·40
Fe_2O_3	=	2·12
NH_3	=	12·78
H_2O	=	9·77
Ingredients not determined	=	11·90
		100·00

Analysis of White Paste (L).		
CaO	=	20·89
NH_3	=	20·29
Cl	=	6·31
Water and binding material	=	52·51
		100·00

[The results of the tests were given in a lengthy series of tables, but these seem of no very great practical importance. The general conclusions from the figures given are to slightly favour the E.C.C. type. The value of the paper is more in the showing that the students at the Technical College are capable of and have the apparatus for carrying out a series of sustained and somewhat delicate testing operations.—ED. *E. E.*]

BELTING FOR MACHINERY.*

BY HENRY A. MAVOR.

The use of belting for driving dynamo machines marks an era in the application of this method of transmitting motion.

The nature of the dynamo machine was from the very first found to necessitate the use of speeds of rotation considerably higher than those usually adopted in engineering practice, except in the cases of centrifugal machinery and of other machinery of so small powers as to call for no special arrangements for driving. For many years after the dynamo became a marketable commodity all such machines were driven by belts or ropes. Of late years many machines, large and small, have been driven by direct connection with the engine crankshaft, and a few by gearing. Of course increased efficiency is obtained by direct connection. Allowance is usually made for an additional loss of at least 15 per cent. in belt and journal friction.

Notwithstanding the many advantages of direct driving, the largest, as well as the smallest, dynamos are still driven by belts or ropes.

There is no sound reason for this. A dynamo machine has the property of instantaneously becoming capable of absorbing a quantity of power limited only by the ultimate strength of its moving parts, and the resistance to heat of its insulation and metallic conductors.

In this respect it differs from all other machines. The friction of a hot bearing brings a machine to rest with comparative slowness. A short circuit in a dynamo has instantaneously to smash or melt something either in the machine or driving gear. The study of belting is therefore of great importance and interest to the electrical engineer, and it is because I have taken an interest in this subject for the past 14 years that I ventured to respond to the invitation of the secretary, and to record my experience.

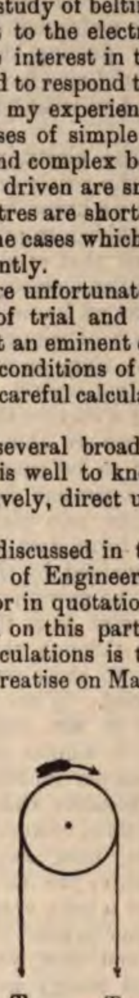
The most difficult cases of simple belt transmission (as distinct from angular and complex belt gear) are, of course, where the pulleys to be driven are small, and the distances between the driving centres are short.

These are precisely the cases which the electrical engineer meets with most frequently.

Successful results are unfortunately only to be attained by the tedious process of trial and error which gradually trains and perfects what an eminent engineer has called the engineering eye. The conditions of practice are so variable that the most exact and careful calculations are only approximate guides.

There are, however, several broad principles established and recorded which it is well to know, and which qualitatively, if not quantitatively, direct us towards the desired results.

These principles are discussed in the articles on belting in Spon's "Dictionary of Engineering," which contain, I think, in original form or in quotation, all the useful matter that has been published on this part of the subject. The base of all belting calculations is the formulæ given by Prof. Rankine in his "Treatise on Machinery and Millwork," p. 351.



f = the coefficient of friction.

θ = the ratio of the length of the arc of contact with the pulley to the radius of the pulley.

n = the arc of contact between the band and the pulley expressed in turns and fractions of a turn.

(1) $R = T_1 - T_2$ = the total friction between the band and the pulley.

$$(2)\quad \frac{T_1}{T_2} = e^{f\theta} = 10^{2 \cdot 7288\, f n},$$

or,

$$\log \frac{T_1}{T_2} = 2 \cdot 7288\, f n.$$

$$(3)\quad \frac{T_1 + T_2}{2\,R} = \frac{e^{f\theta} + 1}{2\,(e^{f\theta} - 1)}$$

We see from this (1) that the power which may be transmitted by a belt and pulley is determined by the difference between the tensions of the driving side and of the following side of the belt; (2) that the ratio of these tensions is determined by two things—viz., the coefficient of friction (that is to say, the ratio: friction or resistance to relative motion of the surface), total pressure forcing the surfaces together, and the angle embraced by the belt.

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* Paper read before the Institution of Engineers and Shipbuilders in Scotland.

It will be at once seen that the value to be given to the coefficient of friction is of vital importance in the beginning of the calculation. This value is precisely the element in the whole question which it is most difficult to determine.

A great deal has been written on the subject, but the authorities are hopelessly at variance in their results. The reason is not far to seek. The value for the friction between a belt and a pulley, determined by any set of experiments, applies only to that particular belt and pulley, under the conditions of the individual experiments. Among the variable elements in these conditions which affect the results are: The condition of the respective surfaces as regards smoothness, dryness, and temperature, and the flexibility of the belt in question.

The results obtained by different experimenters vary as much as between the values of 1 and 3.

The most exhaustive set of experiments with which I am acquainted, carried out under conditions similar to those of actual practice, has been carried by Messrs. Wm. Sellers and Co., and recorded by Wilfred Lewis, of Philadelpia, in the *Transactions* of the thirteenth meeting of the American Society of Engineers, Chicago, 1886. These gentlemen succeeded in producing sets of conditions such that, with the same belt, they were able to vary the apparent coefficient of friction from ·156 to 1·42, or nearly 1,000 per cent. Such a variation as this in a vital factor of the calculation would seem to reduce calculation to an absurdity. The case is not, however, altogether hopeless. Although the variation is enormous, we have a basis of approximation in the fact that it is not difficult to discover for any sample of belting what is the least value which we can give to the friction factor. It is well known to everyone who has experience in using belting that the first run of the belt is the worst, as regards its driving properties.

I have made a small collection of samples of belting sold in the Glasgow market, and with these I have made a series of experiments with a view to ascertaining the friction factor of the belts when they are new and untouched by any oil or dressing.

It is to be clearly understood that these tests are not for the purpose, nor can they serve the purpose of determining the relative merits of these belts. They must be taken as a whole to indicate, collectively, one of the properties of belting *per se*. A set of comparative trials would have to be much more extended, and conducted with more accuracy than I have thought necessary for my present purpose.

Appended to this paper are tables showing the results of these trials, and of tests of tensile strength. The friction trials were made by suspending a 7ft. length of 4in. belting of each of the makes described over a flat-faced pulley 9½in. diameter by 4½in. face suspending weights at T_1 and T_2, and adjusting them so that the belt was just on the point of slipping over the pulley, but remained fast.

The difference $R = T_1 - T_2$ was taken in many of the experiments at about the working strain used by the author for the size of belt tested.

The average coefficient of friction for new dry leather belts as deduced from these experiments is ·153.

The coefficient given by Rankine in the article referred to is ·42, which he says we may safely take in designing machinery, that ·22 is ordinary practice, but that ·15 is to be taken if there is a possibility of the belt becoming wet with oil.

With the most profound deference to this illustrious author, if a belt becomes wet with oil we may find a friction factor of ·00 taking possession of the surfaces, and those of us who have to face enthusiastic crowds waiting the fulfilment of the promise of the coming of the electric light had better face the worst, and while taking precautions to keep oil off our belts, assume a friction factor of ·15 for new belts, and take out our margin between that and a possible ·42 in a longer and easier life for the belt.

Having determined the coefficient of friction, and using Rankine's formulæ, it is easy to find the tension which must be given to the belt to produce the resistance necessary to transmit the required power. Example:

Power required, 10 h.p. = 33,000 foot pounds per minute × 10.
Revolutions of pulley, 1,000.
Diameter of pulley, 12in.

Arc of contact, $\theta = \pi = \frac{n}{2} = \cdot 5.$

$$T_1 - T_2 = R = \frac{33{,}000 \times 10}{1{,}000 \times 3{\cdot}14159} = 105\text{lb.}$$

$$\log \frac{T_1}{T_2} = 2{\cdot}7288 \times {\cdot}15 \times {\cdot}5 = {\cdot}20466.$$

$$\therefore \frac{T_1}{T_2} = 1{\cdot}602 = e^{f\theta}.$$

$$\frac{T_1 + T_2}{2\,R} = \frac{e^{f\theta} + 1}{2\,(e^{f\theta} - 1)};$$

$$T_1 + T_2 = 2\,R\left\{\frac{e^{f\theta} + 1}{2\,(e^{f\theta} - 1)}\right\} = 2 \times 105\left\{\frac{1{\cdot}6 + 1}{3{\cdot}2 - 2}\right\} = 453.$$

$$T_1 - T_2 = \qquad 105.$$

$$\therefore T_1 = 279;\ T_2 = 174.$$

Although I here use the formulæ as given by Rankine, I am sorry to say that I am unable to recommend their acceptance with that faith which mathematicians claim for their mystic symbols. These formulæ proceed on the assumption of perfect flexibility, the calculation proceeding by integration of resultant pressures on infinitely small elements of the arc of contact. There is a possibility that the speed of running the belt may affect the accuracy of the assumption of perfect flexibility. A belt which may be assumed to be perfectly flexible for the purposes of an experiment made with the surfaces at rest, and when there is time for the two surfaces to come intimately in contact, may, when run at a high velocity, and bent and unbent rapidly as it runs, be less completely in contact with the pulley, and this may, along with differences introduced by rise in temperature, produced by the rubbing of the two surfaces slipping relatively to one another, help to account for the differences in the coefficient of friction which have been shown to exist in the American experiments referred to.

The errors arising from these causes are not, however, fatal. We shall see later on, when we come to speak of the strength of belting, that a first approximation arrived at by the method which we have adopted will be sufficiently accurate for practical purposes, and that if any slipping takes place in a belt transmission designed on this basis we have plenty of margin in the strength of the belt to permit of an increase in the tension so as to get the resistance required.

It will be found as a general rule that the assumption of so low a friction coefficient will ensure a satisfactory result.

(To be continued.)

THE CALCULATION OF ALTERNATING-CURRENT MOTORS.—I.*

BY E. ARNOLD.

Since Mr. Tesla published his application of the Ferraris principle, and especially since the Frankfort Exhibition, much work has been done toward the development of the alternating-current motor. The difficulties involved in the problem of meeting the proper requirements of a motor, and the wide gap between a mere principle of a motor and its practical application, both explain why it is that the production of good alternating-current motors has progressed so slowly.

Alternating-current motors can be divided into two groups: (1) synchronous motors; (2) non-synchronous motors. In both of these, the simple alternating current as well as multiphase currents can be used. In the following, both will be considered.

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* From the *Electrical World*.

Synchronous Motors.—These motors are characterised by separate excited field magnets, either by means of a continuous current or by means of a commuted alternating current. Fig. 1 shows a diagrammatic representation of a bi-polar synchronous motor for a single-phase alternating current. A is the armature excited by a continuous current, and F is the field through which the alternating current passes. The direction of the current at that particular moment is shown by arrows, and the armature is in the direction m_1 m_1, which position it will take while running synchronously, when the current of the field has its maximum value. With the assumed polarity of the armature it will be turned to the right, due to the action between the magnetic field and the field current. After every half-revolution this repeats itself, and the armature will, therefore, be able to generate power. If the frequency be n, then a bi-polar motor will make n revolutions per second, while a multipolar machine with z pairs of poles will make $n \div z$ revolutions. The direction of the rotation with synchronous motors is not a definite one, as such motors have a dead point, from which it will turn equally well to the right or to the left. Fig. 2 shows the position at the dead point, which is perpendicular to the line m_1, m_1. If one tries to move the armature out of this position it will swing when released to both sides of the axis m_2, m_2, and will finally be held in this position. The armature takes such a position with reference to the field that the number of lines of force emanating and returning become a maximum in the field coils. If the armature moves synchronously with the field, the position m_2, m_2 will correspond with the time at which the alternation takes place. The reaction on the armature at this moment is equal to zero; but as soon as an overloading of the motor brings it out of synchronism this condition no longer exists, and the armature is brought to rest. The same is true of multiphase synchronous motors. Let:

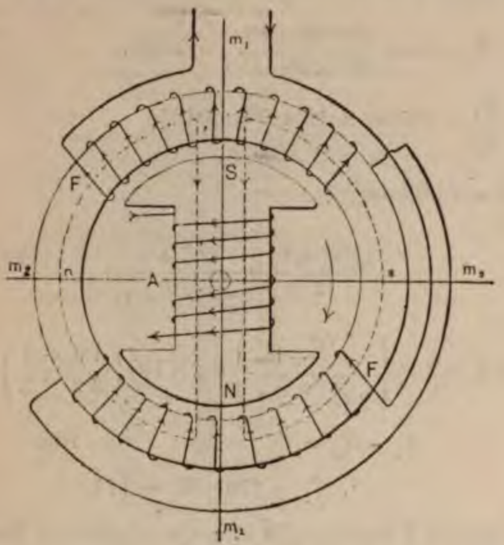

Fig. 1.

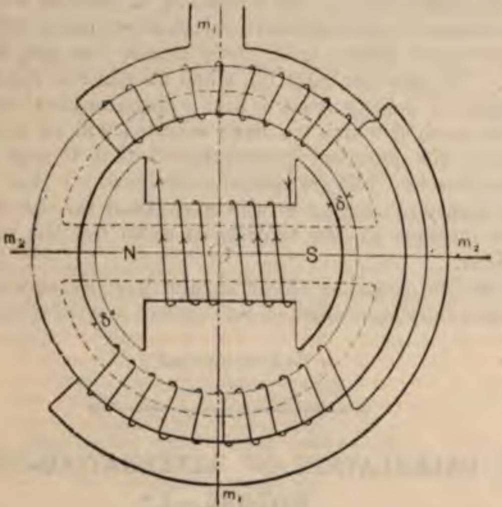

Fig. 2.

e_1 = the mean E.M.F. of the alternating current;
$E_1 = e_1 \sqrt{2}$, the maximum value of the same;
i_1 = the mean current strength;
$I_1 = i_1 \sqrt{2}$, the maximum value of the same;
ϕ_1 = the angle of displacement between E_1 and I_1;
L_1 = the coefficient of self-induction;
R_1 = the resistance of the field coils;
s_1 = the number of windings on same;
H = the mean field intensity (number of lines per square centimetre) in the air-space between the pole-pieces and the field;
$p = 2 \pi n$, in which n is the number of periods per second;
E_c = the counter E.M.F.;
A_1 = the energy delivered to the armature;
A_2 = the energy given out by the armature;
$g = \frac{A_2}{A_1}$, the efficiency of the motor.

The energy delivered to the armature is equal to

$$A = \frac{E_1 I_1}{2} \cos \phi_1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The E.M.F. E_1 is balanced by three E.M.F.'s—namely, first, the E.M.F. of the self-induction, of which the maximum value is $p\ L_1\ I_1$; second, the effective E.M.F. $= R_1\ I_1$, which the current I_1 requires to overcome the resistance R_1; third, the E.M.F. induced by the rotating field, which we call the counter E.M.F. As the field, H, moves synchronously with the current I_1, the phase of the counter E.M.F. will coincide with that of the effective E.M.F. The E.M.F. of self-induction, on the other hand, follows the current I_1 at a phase difference of 90deg., as the self-induction reaches its maximum when the current passes through zero.

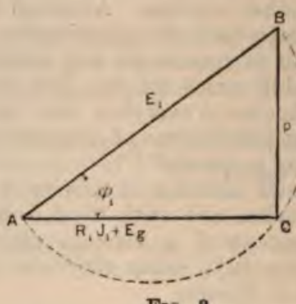

Fig. 3.

If in Fig. 3 A B is made equal to E_1, and if with A B as a diameter a semi-circle is drawn, and if $BC = p\ L_1\ I_1$ laid off as a chord, then $AC = R_1\ I_1 + E_c$ and the angle $BAC = \delta_1$.

The energy delivered to the armature is equal to the product of the current and the counter E.M.F.:

$$A_2 = \frac{E_c\ I_1}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If H is the field intensity corresponding to the load A, then

$$E_c = F\ H\ p\ s_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

therefore

$$A_2 = \frac{F\ H\ p\ s_1\ I_1}{2} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If the resistance R_1, which is small, is placed equal to zero, then it follows from Fig. 3 that

$$I_1 = \frac{\sqrt{E_1^2 - E_c^2}}{p\ L_1} \quad . \quad . \quad . \quad . \quad (5)$$

and

$$A_2 = \frac{E_c}{2\ p\ L_1} \sqrt{E_1^2 - E_c^2} \quad . \quad . \quad . \quad . \quad (6)$$

'hen the armature is at rest, L_1 can be determined ex-nentally, because then the counter E.M.F. is equal to

I_c is the current delivered to the field at the volt-E_o, then it follows from Fig. 3 that $E_0^2 = p^2 L_1^2 I_0^2$ $_1^2 I_0^2$, and therefore

$$L_1 = \frac{\sqrt{E_0^2 - R_1^2 I_1^2}}{p I_0} \quad . \quad . \quad . \quad . \quad (7)$$

y neglecting F_1 it follows approximately that

$$L = \frac{E_0}{p I_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

the armature or the field contains projecting poles or 1, then the value of L_1 depends also on the relative ion between the armature and the field.

'ith the aid of the equations (3), (7), and (8), the value $_2$ can be determined from equation (6) when E_1 is n.

he energy delivered to the armature is

$$A_1 = \frac{(R_1 I_1 + E_c) I_1}{2} = \frac{E_1 I_1}{2} \cos \phi_1 ;$$

the efficiency

$$g = \frac{A_2}{A_1} = \frac{E_c}{R_1 I_1 + E_c} \quad . \quad . \quad . \quad . \quad (9)$$

ne efficiency is, like in continuous-current motors, the of two E.M.F.'s.

ne losses through hysteresis, Foucault currents, and ation of the magnet are not included in this.

ne phase difference between E_1 and I_1 becomes a maxi 1 when $E_c = 0$; that is, when the armature is at rest. larger the counter E.M.F. the smaller will be the angle If the motor delivers no useful work, and if the iture runs synchronously with the field, then E_c has naximum value; I_1 at the same time has its minimum e, as shown by equation (5).

ne energy A_2 is evidently a maximum when, as shown [uation (6), the expression

$$E_c \sqrt{E_1^2 - E_c^2}$$

mes a maximum. If the first differential coefficient is d equal to zero, then

$$E_c = \frac{E_1}{\sqrt{2}} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

h means: the effective energy, A_2, is a maximum when ounter E.M.F. is equal to $1 \div \sqrt{2}$ times the E.M.F., hen the maximum value of the counter E.M.F. is equal e mean value of the E.M.F.

becomes a maximum when it is equal to

$$\frac{E_1^2}{4 p L_1}. \quad . \quad . \quad . \quad . \quad . \quad (11)$$

ne torque, D, of the armature $= \frac{A_2}{w}$ in which w is the lar velocity. For a bi-polar machine $w = p$ and

$$D = \frac{E_c}{p^2 L_1} \sqrt{E_1^2 - E_c^2}. \quad . \quad . \quad . \quad (12)$$

ne torque is therefore inversely proportional to the e of the frequency and to the self-induction co ent.

is shows that in designing alternate-current motors advisable to use the smallest possible frequency.

r synchronous multiphase motors the same results v. If we have in general m alternating currents of maximum intensity, following the sine law, and g a phase difference of $\pi \div m$, then the above for- will hold for each phase. If every phase has an action, then

$$A_2 = \frac{m}{2} F H p s I \quad . \quad . \quad . \quad . \quad (13)$$

$$A_2 = \frac{m}{2 p L} E_c \sqrt{E_1^2 - E_c^2},$$

$$I = \sqrt{\frac{E^2 - E_c^2}{p L}} \quad . \quad . \quad . \quad . \quad (14)$$

etters I, E, and L refer to the single phases.

PHYSICAL SOCIETY.—March 24, 1893.

Prof. A. W. Rucker, F.R S., President, in the chair.

Several excellent photographs of flying bullets and of the air waves produced by vibrating hammers were exhibited, the originals of which had been taken by Prof. Mach.

A paper on "**TheD!fferential Equation of Electric Flow**" was read by **Mr. T. H. Blakesley, M.A.** The object of the paper is to show that the ordinary mathematical expressions for electric flow fail to explain all known facts, and to point out that in order to interpret these facts certain properties of matter not usually recognised must be admitted. The subject is treated both algebraically and geometrically; in the latter case the magnitude being represented by the projections of the sides of a triangle revolving in its own plane on a fixed line in that plane. Taking the ordinary differential equation for a simple circuit having resistance and self-induction—viz., $V - L \frac{d C}{d t} = R C$—it is shown that this takes no account of any energy except that spent in heating the conductor, and that where radiation into space is concerned, it is necessary to introduce another term, λC, where λ is a quantity of the nature of resistance. It is further pointed out that if work be done outside the circuit, the line which geometrically represents the induced E.M.F. cannot be perpendicular to that indicating the current and "effective" E.M.F., the latter term being defined to mean the value of the quantity which is numerically equal to the product of the current into the resistance. A magnetic phase-lag must therefore exist. The author also shows that a magnetic field induced in phase with the magnetic induction would not result in a loss of energy, and no hysteresis could exist. Under the same circumstances, there could be no radiation of energy from an alternating magnet. A Leyden jar discharging through a circuit having self-induction is next considered. Taking the ordinary premises, it is shown that no provision is there made for energy radiated into space, and that magnetic lag is necessary for the existence of such phenomena. The differential equation for the variables in condenser discharges according to ordinary assumptions are shown to be of the same form, and the variables can be represented by the projection of the poles of a triangle which is simultaneously undergoing uniform rotation and linear logarithmic shrinking. The rate of shrinking is the same as that of the radius vector of an equiangular spiral of characteristic angle B, where $\cos \beta = \sqrt{\frac{K}{L}} = \frac{R}{2}$, K, L, and R representing capacity, self-induction, and resistance respectively. The equations and their consequences are considered at some length and several important properties brought out. To allow for radiated energy, R must be virtually increased from R to $R + \lambda$, and the total energy is divided between the circuit and the field in the ratio of R to λ. If, therefore, the circumstances be such that λ is large compared with R—say, by having high frequency—the heating of the circuit may only be a small part of the total energy. In this direction, the author thinks the true explanation of some of Tesla's experiments is to be found, the energy being expended chiefly in radiation, and not in current through the experimenter's body. When obtaining photographs of rapidly-moving objects, Prof. Boys had used discharges of high frequency, but since several sparks of nearly equal intensity were obtained, the decay of amplitude was not very rapid, and the angle β of the logarithmic spiral representing the magnitudes would be nearly 90deg. For the most rapid discharge, $\beta = 45$deg., and the ratio of successive maxima was $\epsilon^{\pi} : 1$—*i.e.*, 23·14 to 1.

Prof. Perry thought the $C^2 R$ term would not represent the heating of the wire when the oscillations were rapid, owing to the distribution of current not being uniform over the section of the conductor. Maxwell had shown that certain throttling terms had to be considered. In condenser discharges the complete equation would have many terms.

Prof. O. J. Lodge said the best definition of R in such cases was that derived from Joule's law rather than that of Ohm's. Frequency was very important in the radiation of energy, but even at ordinary frequencies of alternators some energy was radiated. Referring to Tesla's experiments, he said the reason why no serious consequences followed was that there was not much energy behind them. High frequency might be instrumental in preventing injury, but this he thought remained to be proved.

Dr. Sumpner pointed out that losses other than $C^2 R$ (R being the ordinary resistance of the conductor) had to be taken into account. In some cases, such as transformers on open circuit, the effective resistance might be 1,000 times that of the coil. To discuss completely the problem taken up by Mr. Blakesley, it would be necessary to take account of non-uniform distribution of current both across and along the conductor, as well as the character of the magnetic and electric fields surrounding the circuit.

Mr. Swinburne thought there was a tendency to over-estimate the rate of high-frequency currents, for unless the coils of transformers were assumed geometrically coincident, calculations were difficult. Errors of hundreds per cent. were quite possible. In Tesla's experiments no great power was involved, for the transformer could not give out any large power.

Mr. Blakesley, in reply, said the term R was such that $C^2 R$ represented the whole waste in the conductor, whilst λ included everything wasted outside the conductor.

COMPANIES' MEETINGS.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

An extraordinary meeting of the above Company was held on Tuesday at Winchester House, under the presidency of Mr. C. L. W. FitzGerald (chairman), to confirm a resolution passed at an extraordinary general meeting previously held for reduction of the capital of the Company. The Secretary (Mr. C. Curtoys) then read the notice convening the meeting, and the resolution for confirmation, as follows: "That the capital of the Company be reduced from £307,545, divided into 75,000 preference shares of £1 each, 75,150 ordinary shares of £1 each, and 224,850 ordinary shares of 14s. each, to £234,938, divided into 47 363 preference shares of £1 each, and 75,150 ordinary shares of £1 each, and 224,850 ordinary shares of 10s. each, and that such reduction be effected by returning the amount of £1 per share credited as paid upon each of the 27,637 issued preference shares of the Company to the holders thereof, and thereupon cancelling such shares, and by returning 2s. per share to each of the holders of the 224,850 issued ordinary shares of the Company, and by writing off each of the said 224,850 ordinary shares the sum of 2s. per share, as being capital unrepresented by available assets."

The **Chairman** said that they had met that day simply to confirm that resolution. It was only a matter of form. He would merely inform them in a few words how that resolution had been arrived at. They had received a considerable sum from the sale of the Austrian securities which the Consolidated Company had held. He did not think it necessary to detain them, and he therefore proposed the confirmation of the resolution.

Sir Alexander Armstrong, K.C.B., seconded the resolution.

In reply to questions, the **Chairman** said that the Company had taken legal advice on the matter in Vienna, and that he and two other directors had journeyed to Vienna, and the result of their mission was that they decided to accept as much money as they could get rather than run the risk of going to law. They did not lose anything in the way of money, as they had taken shares from the Austrian Company for the concession. Although they had not lost any money, they did not make the money which they had expected. The preference shareholders had been paid off because they had a priority of claim.

The resolution was then put, and was unanimously adopted.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

The sixth ordinary general meeting of this Company was held on Monday, at the Central Station, Bulmer-place, Notting Hill, W., under the presidency of Prof. Wm. Crookes, F.R.S., chairman. The Secretary (Mr. W. H. Fox) read the notice convening the meeting, and the report and accounts having been taken as read,

The **Chairman** said that before putting the resolution for the adoption of the report and accounts, he proposed to make some remarks. They would doubtless think it unnecessary for him to refer to any great extent to the accounts, as they were published in such full detail that they spoke for themselves. There were, however, one or two points upon which the shareholders might feel interested in having a little information, and he would therefore devote a few minutes to their consideration, although most of them were explained in the report before them. In Table No. 4 there were one or two items on the debit side to which he must draw attention. The first was of hiring temporary boilers, £16. 17s., and to that might be added a further sum of £18 odd, payable for wages and stores, making a total of £35, which would not appear in the accounts this year, as the boilers had been dispensed with, their load being sufficient to render the use of their large boilers economical. Another item was rents payable, £161.10s., which, as stated in the report at the foot of the revenue account, included a sum of £100 for rent of special local office at 105, High-street, Notting Hill, which had now been given up, as it was not considered advisable to take a further lease of the premises. As a matter of fact, the Directors had previously endeavoured to let the house, but could not do so at a reasonable rent. There would therefore be a saving of £135 in the accounts for this year from those two sources, and the Directors also did not expect that the law expenses would be anything like as large as those appearing in the accounts. As would be observed from the credit side of the accounts No 4, the amount of revenue from the sale of current supplied was £2,518, which showed a very satisfactory increase over £999 earned during the previous seven months. The bad debts for the year amounted to only £5. 10s., which he thought reflected credit upon the management in the choice of customers, and in requiring guarantees in doubtful cases. Perhaps a little further explanation was needed with regard to the fee of £250 from the New Telephone Company which appeared in the revenue account. The fee was paid by that company to the Notting Hill Company merely for entering into an agreement whereby, amongst other things, this Company agreed to allow the telephone company to lay wires in their culverts for telephonic purposes at a certain rental per mile of wire, the minimum being £100 per annum; but the provisions of the agreement took effect conditionally upon the granting of the necessary approval by the Board of Trade and other authorities, which had yet to be obtained. Coming to No. 5, the net revenue account, on the debit side of which appeared an item of £92. 16s. for interest on loans, they did not anticipate any similar liabilities being incurred this year, as the charge was for interest payable to the contractors in connection with the construction of the Phillimore district mains, to which he would presently again refer. The debit balance of £617 which appeared in the net revenue account at the end of the previous year had been reduced to £347, but that was chiefly through the amount of £250 of Directors' fees being re-credited in the accounts. In explanation of that, he mentioned that the total amount of fees payable to the Directors under the articles of association was £1,000 a year, and as stated in the last report, the Directors had not drawn fees for the quarter ending 31st December, 1891, and had not drawn any since that time. Therefore, on the 31st December last, the total amount of fees due to the Directors was £1,250. In view, however, of the present struggling position of the Company, the Directors had agreed to return to the Company half of the fees due, and they had also agreed to accept half fees for the present year; they had gone further than that by deciding to postpone their claim for half fees due, together with those of this year, until the accounts were presented in 1894. An agreement embodying those arrangements had been prepared and signed by all the Directors. As regarded a depreciation fund, No. 7, they would notice that the Directors had not thought it necessary to provide for depreciation, as they were advised that the charges in the revenue account under the head of repairs and maintenance were sufficient for the purpose; and he would add that the mains and machinery were kept in such a thorough state of efficiency that it did not appear to necessitate, at least at present, any special provision for that being made. He did not think there was anything in the general balance-sheet which required comment The last account was statement of electricity generated, sold, etc., the only figure needing explanation being that under the head of quantity not accounted for. Of the 13,061 units said to have been absorbed by the batteries, he thought it would be fair to charge the batteries with only 9,000 units, the balance being debited to losses in meters, and the difference between the current at 101 volts, which was actually given to consumers, and the current at 100 volts, which they charged to them. The 2,268 units lost in the mains represented the amount of energy expended in overcoming the resistance of the mains. The actual quantity not accounted for was therefore only 61 units, and he did not think that any other London company could show such a satisfactory result. During the year they had made several extensions of mains, but the principal one was that to the Phillimore district, and it was with the special object of making that extension that the ordinary preference shares were issued. Before however, finally deciding to extend to that part, the Directors took great care to ascertain the amount of support likely to be received in the neighbourhood, and on finding that there was every likelihood of obtaining a satisfactory return on the capital outlay, it was resolved to carry out the work. The Directors were pleased to find that their estimate was correct, and they had already a good number of houses connected to the mains. At one time it was thought that it would be necessary to have a battery station to supply that district, but they had been able to supply without it. Since the end of last year the Company had made a further extension to Observatory-gardens, but in this and in the case of several small extensions carried out last year the Directors had obtained advances from those interested at least equal to the bare cost of the work done to be repaid by not charging the consumers on the extensions for any current consumed until the loans had been paid off. They had found that the plan acted well. The item of £485 in account No. 8, debtor side, showed the debits made in such cases to cover the guarantees. These were only repayable by their not charging the consumers for current until the loans had been paid off. They would, therefore, see that the Company did not run any risk with those extensions. The guarantees varied according to the necessities of the case. He thought they might say that those were the only instances where there were any charges on the Company. The cost of the Phillimore extension had been £6,500. The number of houses on the extension already wired and lighted was 17, and the number of lamps reduced to a uniform 8 c.p. was 1,351. The estimated revenue from that extension was £500 in the current year, and £600 in 1894. As they were aware, the Directors, in May last obtained the sanction of the shareholders to issue the balance of the ordinary shares, amounting to £29,980, in the form of ordinary preference shares, bearing a cumulative interest of 6 per cent. Those shares were in the first instance offered to the shareholders in proportion to their holdings, and up to December 31 last 796 shares, representing £7,960, and since that date the Directors had allotted 20 in addition. Practically, the whole of the capital received from the issue of those shares had been spent in making extensions of the mains and in the purchase of additional machinery required owing to the increased area of supply. No money was now owing to Messrs. Crompton and Co., the contractors for construction, though an arrangement had been made that the money could have been borrowed in the event of the preference issue not having been successful. The Company's property, with the trifling exception of extensions made with consumers, as already mentioned, was quite free, being saddled with no mortgage debentures or charges. When they met at the last general meeting, they had 77 houses connected to the mains, representing 6,056 8-c.p. lamps, and which by the end of December last had been increased to 124 houses and 9,438 lamps, or an increase of 47 houses and 3,382 lights. So far as the present year was concerned, the increase in the number of houses, in proportion to the whole of last year, had been slightly larger, so that if the steady increase was maintained, as they expected would be the case, they might expect very shortly to be in an extremely sound condition, and yielding to the shareholders substantial returns on their investments. The present number of lamps on their mains was 9,854, bringing in an estimated revenue of £3,500 per annum, but by the end of 1893 they might reasonably expect the increase of lamps to be such as to raise the revenue to £4,000. During the year the mains and machinery had worked in a most efficient and satisfactory manner, and, with the exception of three instances during the winter, when some of the mains were flooded owing to the bursting of the water-mains, no accident of any kind had occurred. In each case the flooding of the culverts happened in frosty weather, and the escaping water undermined that particular part of the roadway and filled the culverts with water, consequently making a connection between the strip and causing a loss of 240 units. In the place, however, where those accidents happened, the Directors had thought it advisable to specially drain the culverts, and they were also making representations to the London County Council with a view to prevent a recurrence of the nuisance, as the real cause of the trouble was the blowing out of the fire plugs, which were old fashioned wooden ones, which ought to be replaced by something of a more modern type. There was only one other thing which had occurred during the year—that was a considerable leakage of water in the basement of the central station, and which was likely to damage the foundations of the machinery. He was glad to say that after some time the source of leakage had been discovered, and by constructing some drains outside the station, the leakage had been stopped. There was one thing which he regretted to say had not reached their expectations—that was the income per lamp per annum. The estimate he gave last year was 10s., and from the results obtained by other London companies, there was reason to believe that they might exceed that sum. They found, however, that the actual revenue per lamp was only 7s. It was difficult to account for that difference; possibly it was owing to Notting Hill being on a higher elevation, and also to its being less affected by foggy weather. It was also noticed that as confidence in the stability of the light grew, customers wired their houses and put up more lamps than they intended to use ordinarily, as, for instance, at balls, etc. At first the tendency was to put lamps where they were wanted nightly; afterwards, when the bugbear of increased expense was found to be a negligible item, consumers went to the opposite extreme and wired their houses and put up lamps for use on special occasions. It was with the object of increasing the amount of revenue per lamp that they had introduced a scale of rebates, in which, however, consumers did not participate until the revenue per lamp for the year had reached the standard price of 10s. Then a rebate of 5 per cent. was made, the highest deduction being 25 per cent. in cases where the average yield per lamp reached 30s. When they considered that the average yield only reached 7s. per annum, they could well understand that the cases in which the full rebate could be claimed were few and far between. There were 19 consumers who, according to last year's statistics, benefited by the reductions. One would get a reduction of 25 per cent., and the total amount of the rebates would be about £75. The Directors were now contemplating extending their work westwards, and so following up the remainder of their district; but before proceeding they were waiting to hear what support they would secure. The proposed extension for Melbury-road battery station would be £16,000; but a complete station with boilers, engines, etc., would cost £36,000. It would be useless to spend thousands which would not pay for the maintenance of cables for the supply of current. The basis the Directors were going on was that the gross revenue should be on such a scale as to repay the capital expenditure in from four to five years. That would mean, without any increase, that they might get 5 per cent. for their extra capital expenditure at the end of five years. If they were to work for less than that, the business of the Company would be too speculative. It would be wrong not to secure their way as they went along. In conclusion, he drew attention, in view of the steady increase in the Company's business, to the future prospects of the Company which appeared bright, and he hoped on the next occasion that he would be able to propose a resolution declaring a dividend. He then moved the adoption of the report and accounts.

Mr. Sidney Waters, in seconding the motion, observed that it was quite evident that the rate of progress of a company of that kind depended to a large extent upon the general commercial prosperity. The Company was started just after the time of the Baring failure, and since then there had been a period of depression which had weighed heavily upon them and upon the prosperity of England generally. That period, they now hoped, was passing away, and with a revival of prosperity and better times a company of that nature would be the first to feel the benefit. During times of depression people were reluctant to go to the expense of wiring houses and in incurring fresh outlay, but now that there were hopes of the time of depression passing away, they hoped that their business would materially improve.

The **Chairman**, finding that there were no observations made, then put the motion for the adoption of the report and accounts. This was unanimously carried.

Mr. J. T. Jervis moved, and **Mr. Dutton** seconded, the re-election as directors of Messrs. W. Crookes and S. Waters. This was adopted. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were reappointed on the proposal of **Mr. Benson**, seconded by **Mr. Aston Webb**, and the proceedings closed with a vote of thanks to the Directors.

DIRECT SPANISH TELEGRAPH COMPANY.

The thirty-ninth half-yearly ordinary general meeting of the shareholders in this Company was held last Friday at Winchester House, Old Broad-street. In the absence, through illness, of Sir James Anderson (chairman of the Company), Mr. Edmund Etlinger presided.

The **Chairman**, in moving the adoption of the report and accounts, after informing the shareholders that there was a decided improvement in the condition of Sir James, remarked that the half-year under review, ended December 31, 1892, had been very uneventful, and traffic receipts had shown an increase, but only very slight. On the other hand, their expenses had been very much the same as they were before. Now, considering that the trade and commerce of the world had not been brisk—in fact, he believed the public said it had been very slack—and that there had been no political event which would throw extra work upon Spanish wires, he thought they had every reason to be satisfied. On the whole, they were £410 better off this half than they were last half-year. They might also congratulate themselves upon the fact that during the past half-year there had been no money expended upon cable repairs, and the small works they had carried on in connection with the land lines at Falmouth, Bilbao, and Barcelona had been completed at the small expenditure of £171, which had been charged against revenue. Turning to the figures, he said they would see that the Board had spent nothing on capital account, neither had they raised any additional capital nor contracted a loan. The debentures also remained as they were before. As was explained at the last meeting, these debentures fell due in May, 1894, but that fact, he thought, need cause them no anxiety whatever. By that time they would have a reserve of £40,000. They had an annual net income of £14,000, and an uncalled capital of £13,000, and, under the circumstances, there could be no difficulty when the time came, in meeting the debentures. On the present occasion, however, there was no occasion to go into that. During the 12 months they had increased the reserve fund by £6,000 odd. That, he thought, would be considered satisfactory. As to the outstanding liabilities of £12,688, that represented balances in connection with other telegraph administrations due to them at December 31st last. These were more than counterbalanced by the amounts due to them from foreign administrations amounting to £18,000, but since December last both these amounts had been very much reduced. After providing for debenture interest there remained a balance to the credit of profit and loss of £5,438. The traffic receipts showed an increase of £30 as compared with the corresponding period of 1891. The working expenses were £56 in excess of those for the corresponding period of last year. The cables and land lines in connection with them had continued in good working order throughout the half-year. The Directors, with a view to strengthen the good relations existing between the Company and their staff, proposed to follow the practice adopted by many companies, in assisting their employés to make provision for their old age, or for their representatives after death. Arrangements had been made for taking out endowment policies on which, under certain conditions, the Company paid one-half of the premiums. It was calculated that the amount which the Company could be called upon to contribute would not exceed £250 per annum. After adding the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounted to £2,938. Out of this amount they recommended the payment of a dividend at the rate of 10 per cent. per annum on the preference shares and a dividend at the rate of 4 per cent. per annum on the ordinary shares. There would then remain a balance of £442, which would be transferred to the reserve fund in part repayment of the balance of £1,935 still remaining due to that fund for the repairs of the Falmouth-Bilbao cable in November, 1891. The reserve fund now amounted to £33,273.

The motion was seconded by **Mr. J. D. Pender**, and carried unanimously, without comment.

The dividend having been declared, the retiring directors (Messrs. Etlinger and Pender) were duly elected, and the proceedings closed.

NEW COMPANIES REGISTERED.

Printing Telegraph and Construction Company of the Agence Havas, Limited.—Registered by Slaughter and May, 18, Austinfriars, E.C , with a capital of £115,000 divided into 23,000 shares of £5 each. Object: to acquire by purchase or on royalty, or otherwise, the exclusive or non-exclusive, or limited right to use or vend within the Republic of France, and to grant licenses for the using and vending of all or any of the inventions relating to printing telegraphs or improvements therein; with a view to the foregoing to adopt and carry into effect an agreement to be made between Robert D. Radcliffe and Laur von Viben-Smith of the one part and this Company of the other part, and also an agreement expressed to be made between l'Agence Havas (a French société anonyme) of the one part and this Company of the other part, and to carry on in France, in connection with the Agence Havas, the business of transmitting the news of the day to subscribers, and to deal in all things incidental to improvements in telegraphy in France. The first signatories are:

	Shares.
Colonel W. J. Engledue, Petersham-place, Byfleet	1
W. H. Russell, 167, Victoria-street, S.W.	1
C. Cammell, Sheffield	1
W. C. Slaughter, 18, Austinfriars, E.C.	1
J. E. Wright, 670, Hudson-street, New York	1
H. Houssaye, 9, Rue St. Florentin, Paris	1
R. D. Radcliffe, 50, Lime-street, E.C.	1

There shall not be less than three nor more than seven the first to be elected by the signatories to the memorandum of association. Qualification: £200. Remuneration: Chairman, £300 per annum; ordinary directors, £200 each per annum, and 5 per cent. of the profits after payment of 5 per cent. dividend on the paid-up capital of the Company.

English Electric Carbon Company, Limited.—Registered by Kennedy, Hughes, and Kennedy, 1, Clement's-inn, W.C., with a capital of £10,000 in £10 shares. Object: to carry on business as manufacturers of and dealers in electric and other carbons at the Smelt, near Brynbo, Denbighshire. The first directors, to be not less than three nor more than six, are J. H. Darby, Sir A. M. Robertson, W. Darby, and E. Mahla. Qualification, 50 shares.

BUSINESS NOTES.

Telephones at Swindon.—A new telephone exchange has been opened by the National Telephone Company at New Swindon.

Brighton.—The tenders for supply of are lamps and switches for the Brighton Corporation must be sent in before 10 a.m. on Tuesday.

Hanley.—The Hanley authorities are progressing with the necessary preparations for lighting the town by means of electricity.

Globe Telegraph and Trust Company.—An interim dividend of 2s. 3d. per share has been declared by the Board, payable on the 18th prox.

Halifax.—The Electric Lighting Committee, it is said, are going to utilise the Corporation's property in Stead-street as a central station.

Anglo-Portuguese Telephone Company.—At a meeting of the shareholders, held yesterday, a dividend at the rate of 5 per cent. per annum was declared.

"**Lightning.**"—The editorial and publishing offices of *Lightning* are removed from Charing Cross-road to Mansion House-chambers, 11, Queen Victoria-street, E.C.

Change of Address.—Messrs. Wake and Sanders, mica merchants, late of Fowkes-buildings, E.C., ask us to state that they have removed to 3, Crosby-square, E.C.

Barnet.—The Board of Trade has supplied the Barnet Local Board with copies of the proposed provisional order, which has been approved with a few minor alterations.

Brussels Electric Railway.—Messrs. Alexander Penney and Co. are agents for the proposed Brussels electric underground railway, for which Mr. Greathead is engineer.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,348.

Hackney.—The Hackney Board of Works have confirmed their resolution of last October authorising the application to the Board of Trade for a provisional order for electric lighting.

Ballarat.—A joint committee, representing the city and town of Ballarat, Australia, has decided to recommend that united action be taken for the establishment of the electric light in the two municipalities.

Huddersfield.—The Huddersfield Town Hall is to be closed during the summer for renovation and redecoration, at a cost of £1,500. This amount does not include the price of electric light, which is to be the future illuminant.

Auditor.—The Bournemouth and District Electric Supply Company applied to have an auditor appointed, under the Act of 1882. The Council elected Messrs. Bicker Bros., on the motion of the Chairman, seconded by Mr. J. C. Webber.

West Metropolitan Tramways.—A Select Committee of the House of Commons on Tuesday passed the West Metropolitan Tramways Company's Bill, which authorises the Company to work their system by electrical or mechanical power.

Derby.—Tenders are required by the Derby Corporation for mains, transformers, lamps, posts, and accessories. Plans may be seen at Messrs. Bramwell and Harris's, 5, Great George-street, and the tenders must be sent in by April 17, at noon.

Direct United States Cable Company, Limited.—The Directors announce the payment of an interim dividend of 3s. 6d. per share, tax free, being at the rate of 3½ per cent. per annum, for the quarter ending March 31, 1893, payable on April 24.

Whitehall.—The Council of the Royal United Service Institution have instructed the General Electric Power and Traction Company, Limited, to put in an electric lighting plant in the old Chapel Royal in Whitehall, which is being altered for the new museum.

Telephones.—Messrs. Gent and Co., Leicester, have secured the contract for fitting the Holborn union infirmary with 20 sets of their "Combination" telephones, also a 20-station central indicator and switchboard, using the existing bell wires for the telephone circuits.

Electric Supplies.—Notice is given by Messrs. Slaughter and May, 18, Austin-friars, for Mr. John Scott, liquidator of the Electric Supplies and Fittings Company, of 8 and 10, Charing Cross-road, that all creditors of the same are required to send in *their claims by April 25.*

City and South London Railway Company.—The receipts for the week ending March 26 were £859 against £818 for the corresponding period of last year, or an increase of £41. The total receipts for 1893 show an increase of £1,048 over those for the corresponding period of 1892.

Anglo-American Telegraph Company, Limited.—The Directors have declared an interim dividend for the quarter ending March 31, 1893, of 12s. 6d. per cent. on the ordinary and 25s. per cent. on the preferred stock, less income tax, payable on May 1 to the stockholders registered on the books on March 31, 1893.

Rotherhithe.—The London Electric Supply Corporation have written to the Rotherhithe Vestry giving notice that, after the expiration of a month, and in pursuance of the London Electric Supply Order, of 1889, they intend to lay trunk mains in Bush-road, Rotherhithe New-road, Raymouth-road, and Southwark Park-road.

Niagara.—Five electrical companies have entered for the Niagara contracts—Oerlikon Company; Brown, Boverie, and Co.; Compagnie de l'Industrie Electrique, of Geneva; General Electric Company, of New York, and the Westinghouse Company. All these have submitted plans, designs, and miniature plants. Alternating currents will be used, and the unit is 5,000 h.p.

West-end.—During the past week Messrs. Rashleigh Phipps and Co. has received the following private houses in the West-end to light up: Lady Pearson, 75, Onslow-square, S.W.; Dr. Watson Cheyne, 75, Harley-street, W.; Mrs. Hart, 89, Gloucester-terrace, W.; Mr. Herbert Lousada, 27, Green-street, Park-lane, W.; also additions, etc., to Baron Ferdinand de Rothschild's house, 143, Piccadilly, W.

Edison Company.—The Edison Electric Illuminating Company proposes to issue 3,500,000dol. additional stock; 3,250,000dol. will be required to retire its outstanding bonds. The remaining 250,000dol. will be used during the year for the development of the business of the Company, and, when so used, may be issued to the stockholders, probably at par, providing in that way an additional dividend of 1 per cent.

Eastern Telegraph Company.—The Directors announce the payment on April 14 next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares of the Company for the quarter ending March 31, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended December 31 last. The register of transfers will be closed from April 7 to April 14, both days inclusive.

Electric Capstan.—A new capstan, worked by electricity, has just been fixed by way of experiment at No 12 tip, Barry Dock. This is the first one of the kind introduced, and is capable of pulling upwards of 50 coal waggons at a time, a feat which totally eclipses any capstan worked by hydraulic machinery. It is expected that the Barry Company will adopt this system at all the tips. The capstan was fitted, and is at present under the sole supervision of Mr. Evans, the company's electrician.

Bournemouth.—The Local Government Board have enquired whether the Bournemouth Town Council mean to generate their own current for lighting the gardens and pier with electricity, warning them that they will require a provisional order before doing so. At the Town Council meeting last week the Clerk, replying to Councillor Stockley, said they could not get a provisional order this year, but they might secure a license in about four months. The cost would be £40 or £50, and it would be valid for seven years. The letter was referred to committee.

Londonderry.—The following are the accepted tenders for street-lighting with 160 arc lamps, for the Londonderry Town Council:

Siemens Bros. and Co, dynamos, arc lamps, conductors, etc.	£8,905
A. Brown and Sons, engines, boilers, etc.	4,293
M. M'Clelland, buildings	995
M. M'Clelland, purchase of site	600
Amount of tender for opening and closing streets	300
Engineer's fees	700

Exeter Tramways.—At the Exeter City Council last week, the Streets Committee stated that, having regard to the experience of the Council in connection with the existing tramways, they could not recommend the Council to consent to the proposal to lay down tramways in Queen-street. With regard to the proposed alteration in the method of traction from horses to cable or electricity, they recommended that before expressing any opinion upon the subject the Council should require a definite scheme to be submitted to them, with full details of the method proposed to be adopted.

Dewsbury.—Tenders are required by April 8 for the Dewsbury Corporation for the construction, supply, and laying down the necessary plant and mains for the supply of electricity in the borough, in accordance with specification, plan, and form of tender, which can be obtained from Mr. E. Mawdesley, town clerk, Town Hall, Dewsbury, on payment of two guineas, which will be returned on receipt of a bona fide tender. The person or firm whose tender is accepted will be required to enter into a contract and a bond with two approved sureties for the performance of the contract. Firms tendering may tender for the whole or any part of the plant.

City Lighting.—The Finance and Improvement Committee of the City Commission of Sewers brought up a report relative to an application of the City of London Electric Lighting Company for the Commission's assent, as the local authority, to the introduction of a Bill for amending Section 8 of the electric lighting order. The object of the proposed Bill would be to abrogate the provisions for setting aside 7½ per cent., on the capital expended, for depreciation. The committee were unable to recommend compliance with the application. Mr. W. H. Pannell said he thought the report should be reconsidered. His suggestion was accepted by the committee.

Electrically-Welded Barrels.—According to *Industries*, a new industry is about to be started at Barrow, which, though at the commencement will necessarily be of small dimensions, possesses the elements of expansive development by the fact that the product is one likely to be in growing demand. It is intended to commence the manufacture of steel barrels for the purpose of carrying petroleum. The barrels are made in halves, of light steel, and are afterwards welded together by electricity. The works at Barrow which are being utilised for this novel manufacture are those of Mr. Caird, shipbuilder, who is interested in the Kerosene Company, Limited, for which large tanks, capable of holding 2,800 tons of oil, to be erected at Batoum, are now being built at Barrow.

Croydon Town Offices.—The Croydon General Purposes Committee stated at the last Town Council meeting that the surveyor had reported on the cost of connecting the new union offices with the telephone, so as to be available also for the workhouse and infirmary. The cost, including diverting and supplying and fixing the instruments, battery, bell indicator, and switch, would be £7. 10s.; the work would be carried out for this sum by Messrs. Anders, Elliott, and Co., and the National Telephone Company's charge for the extension line and instruments, with switch arranged, would be £3. 3s per annum. The committee recommend that these works be carried out at the cost stated, and that the Board enter into an agreement with the National Telephone Company for the extension to the new offices.

Bromley.—A Local Government enquiry was held recently by Mr. Frederick H. Tullock, inspector, as to the borrowing of £3,175 for purchase of a site for electric lighting at Bromley. Prof. Kennedy said he had examined the roads of the town with a view to considering the mains and the best point for the station. The estimated cost of the arc lighting plant, mains, and roadwork would be from £2,500 to £4,500. That would suit for the lighting of the public streets and could be supplied to such private consumers as desired it. These costs did not include land or buildings. He made a further estimate for the whole parish. To the end of Widmore-lane to Bromley Common and Shortlands, would be £7,500 for public and private lighting. In the first estimate there would be 25 arc lamps, which would displace 68 gas lamps, equal to £850 for electricity and £240 for gas, a difference of £610.

Donegal.—The electric light is gradually making its way into the most remote districts in Ireland. In the County Donegal, in the extreme North, an installation is being put down at the residence of Mr. J. Watt, of Claragh. It is intended to use an oil-engine of the Hornsby-Akroyd type to work direct on to a Norwich compound dynamo. A set of accumulators of the E.P.S. type are included, and these are so controlled by an ingeniously-devised switching arrangement as to enable one half the battery to be charged at the same time that the lamps are alight. By this arrangement it will not be necessary to work the engine specially for charging the accumulators, and thus there will be a considerable saving in fuel, as the engine while running will always be fully loaded, and there is, therefore, no waste of power. The installation is being carried out by Messrs. Laurence, Scott, and Co., of Norwich, to the specification and under the superintendence of Mr. Angelo Fahie, M.I.E.E., consulting electrical engineer, of Dublin.

Datchet.—The Manor Hotel, Datchet, on the Thames, near Windsor, is about to be lighted throughout by electricity, Mr. Druce, the proprietor, having instructed Messrs. Roger Dawson and Co., Limited, who are represented by Messrs. Harris and Donnison, to put down a plant for 70 or perhaps rather more lights. The work will be carried out under the superintendence of and to plans and specifications drawn by Mr. A. Farrow, electrical engineer to the White Hart Hotel, Windsor, and the plant will comprise a 3-h.p. nominal Crossley's "Otto" gas-engine of the latest electric-lighting type, with two flywheels to ensure greater steadiness; a three-unit "Taunton" dynamo, with Kapp's patent armature; one set of 27 E P.S. cells, 23 L type, which will be capable of maintaining the whole of the lights for nine hours; one E.P.S. cut-in and cut-out automatic switch, and an excess alarm bell to ring in the house, as well as in the engine-room, when the charge or discharge exceeds 45 amperes; and one of the contractors' new "omnibus bars" distributing-boards. The gas will be supplied by the Slough Gas Company.

Printing Telegraph (Agence Havas).—Shares have been issued this week in the Printing Telegraph and Construction Company of the Agence Havas, Limited. Capital £115,000. Issue of £115,000, in 23,000 shares of £5 each, of which £15,500, or 3,100 shares, are taken by the vendors, and the balance of £99,500 in 19,900 shares of £5 each is offered for subscription at par. The directors are: Colonel W. J. Engledue, late Royal Engineers, and late an engineer-in-chief and manager Indian State Railway Department, Petersham-place, Byfleet, Surrey; Charles Cammell, Esq., director Charles Cammell and Co., Limited, Sheffield; W. H. Russell, LL.D., late special correspondent of the *Times*, 167, Victoria-street, S.W.; George Bush, Esq., M.I.C.E., 3, Gracechurch-street, E.C.; Monsieur D. Monnier, professor of industrial electricity at l'Ecole Centrale de Paris; Monsieur H. Houssaye, managing director Agence Havas (will be appointed managing director in Paris). Secretary (*pro tem.*): Theodore J. Ford, 11 and 12, King William-street, E.C. Temporary offices: 11 and 12, King William-street, London, E.C. This Company is organised to acquire the French patent for the latest improvements in printing telegraphs, and thereby and therewith, in conjunction with the Agence Havas, to construct the systems for the transmission of the news of the day to subscribers in France, and, with the assistance and concurrence of the Agence Havas, to deal generally in France with improvements in telegraphy.

Sheffield.—At the half-yearly meeting of the Sheffield Gas Company, the chairman, Sir Frederick Mappin, gave some statistics of the progress of gas and electric light companies. The capital invested in the former in 1882 was £50,261,000, which had increased in 1892 to £63,620,461, a very large increase in face of the progress of the electric light. The gas made by these companies in 1882 was 66,614 million cubic feet, and in 1892 it was 99,870 million cubic feet. Electric light companies during the short time they had been before the public had not had an opportunity of investing so much money. The registered nominal capital was £9,700,000, and the capital called up £3,820,000 exclusive of the amounts expended by municipal and local authorities, and other public companies which did not require to be registered. Although electricity was progressing to this extent he did not think they were in a position to feel its effect very much. Judging from the experience in St. Pancras parish, and at Bradford, they were justified in assuming that the electric light would, as a rule, cost the people three times as much as gas had hitherto done. He was very sorry to find that the West Riding County Council had decided to put the electric light into Wakefield Asylum. He thought the ratepayers should not sanction a thing of that kind, putting a light of luxury into a building of that character. So far as he could see, those of them who were interested in gas undertakings had no reason to fear that their capital would be at all jeopardised by the electric light. He cordially hoped that both systems would go on together without the feeling of jealousy that at one time existed. In conclusion, he advised all gas consumers to look carefully to their burners and gas fittings, and then he felt sure they would be satisfied with the light, and have no desire to resort to the much more expensive illumination by electricity.

Lancaster.—At the meeting of the Lancaster Town Coun last week, an important report of the Electric Lighting Committee, of which Mr. Smith, M.P., is chairman, was presented. It states that the committee have decided that the system suitable for Lancaster is the low-tension continuous-current, with insulated cables drawn into conduits made of bitumen concrete on the Callender-Webber drawing-in system. After careful consideration it was decided not to put down the whole of the machinery included in the original scheme, but to erect only a portion. By so doing the capital expenditure will be kept down until the revenue increases, as in the first year's working the load or number of lamps installed is almost sure to be comparatively small, and if the whole of the machinery were put down at once it would simply have to stand idle until the demand increased. It is intended to at once make provision, so far as the cables and buildings are concerned, for the supply of energy for 6,000 16-c.p. lamps, this being the original scheme of the committee. It is proposed to place the generating station in Marton-street-yard, which belongs to the Corporation. Mains, with the necessary feeders, have to be laid at once in certain principal streets. It is, of course, intended to supply other portions of the borough with electric light when the committee feel that the consumption will justify the necessary cost of extending the cables. The committee recommend the Council to accept the tender of the Brush Electrical Engineering Company, amounting to £12,683. This amount is exclusive of the cost of buildings, and the laying of the mains; these works to be carried out by the Corporation, at an estimated cost of not more than £5,000. The price to be charged per unit has not yet been decided upon. It is expected the installation will pay its own way at 7d. per unit, which is the price usually charged to begin with.

Bristol.—Says the *Bristol Times and Mirror*: "The other day it was stated that the Bristol installation of the electric light might be expected by September. It might have been forgotten what the exact area proposed to be first lighted is, and therefore we give the names of the thoroughfares, which are: Victoria-street, High-street, Broad-street, Corn-street, Clare-street, St. Augustine's Bridge and Parade, College-green, Park-street, and Queen's-road (as far as the Victoria Rooms), Old Market-street, Castle-street, Peter-street, Dolphin-street, Union-street, Bridge-street, Wine-street, Balwin-street, St. Stephen-street, and Small-street. The committee have accepted the tender of the Brush Company for the appointments of the sub-stations at a cost of £1,752, and Messrs. Siemens will at once begin to put in the mains. The tenders for the switchboards are still under consideration. Mr. Preece has supplied the committee with such information as to enable them to issue a circular to possible private consumers in the area to be publicly lit. Mr. Preece takes a very favourable view of the financial prospects of the scheme, for which a first instalment of £2,660 is included in the Sanitary Committee's current estimate. Two financial statements are prepared by Mr. Preece—one upon the assumption that all the available electrical energy will be required for private purposes, and a second assuming that only a half of it is to be utilised for the present. His calculations are based on the use of a 35-watt lamp, which compares favourably with a gas-burner consuming five cubic feet of gas, each such lamp giving a light of about 10 candles, and he takes the annual consumption per lamp in Bristol at 18 supply units. The plant itself will maintain 14,000 such lamps at one time. This really implies that 28,000 such lamps may be connected to the mains, because of the total number fixed the maximum proportion alight at one time will never exceed one-half."

French Elmore.—"W," a small shareholder in the Elmore's French Copper Depositing Company, writes in the *Financial News* for Wednesday to show that, unfavourable as the directors' report seems, the position is not so black as has been painted. After going into cost of production, he says: "Assuming the cost of manufacture £19. 10s. per ton, as proved, with only 14 tons per week, and the above charges for interest, depreciation, and management, I find the following results: An output of 25 tons per week selling at 9d. per lb. (say 2·03f. per kilo.) would give 5 per cent. dividend on the 10 per cent. preference shares; the same output selling at 10d. per lb. (say 2·35f. per kilo.) would give 10 per cent. on the preference and 4 per cent. on £200,000 ordinary. An output of 35 tons per week selling at 9d. per lb. (say 2·03f. per kilo.) would give 10 per cent. on the preference and 5 per cent. on ordinary; the same output selling at 10d. per lb. (say 2·35f. per kilo.) would give 10 per cent. on the preference and 10 per cent. on ordinary. Surely, with a plant sufficient for 75 tons per week, there is ample scope for greatly superior results. One word more I would like to add—viz., that the whole of the 28 months' loss given by the committee (large as it undoubtedly is) represents less than 15s. per share of £2; and yet these shares are being practically thrown away. Some preliminary expenses, at least, must be incurred in the inception of any new large manufacturing business."—At the conclusion of a long letter to the *Financial Times* of Wednesday, criticising the Elmore process and the proceedings of the Elmore companies, "A. S. F." states: "The whole question of success or failure of the Elmore process at present seems to depend upon whether or not they can sell 15 to 20 tons of steam-pipes per week. I do not believe they can make steam-pipes—that is, make a quantity regularly which shall give uniform results. But here is a fair proposal which should settle the matter. Is Mr. Elmore prepared to run 20 tanks in series for a fortnight, and sell the whole of the products as steam-pipes, or submit any five of them to hydraulic test? Twenty tanks would only mean perhaps less than two tons of copper—one-tenth part of the stated capability of the tube works—and such a test should certainly be made before any further money leaves the shareholders' pockets."

PROVISIONAL PATENTS, 1893.

MARCH 20.

5878. **Reducing magnetic disturbances caused by the electric currents, dynamos, and motors of electric railways and other undertakings.** Charles Vernon Boys, Royal College of Science, South Kensington, London.

5935. **Combined electric and compressed-air motor.** William J. Walker and Alexander L. Bedford, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5944. **Electricity meter.** Alfred Edmund Parnacott, The Ferns, Laurel-grove, Penge, Surrey.

MARCH 21.

5987. **An improved method of reducing electrical induction on telephone and other circuits.** George Edwin Fletcher, The Homestead, Call-green, Stockport.

6000. **Improved methods for effecting the electro-fusion of steel and its alloys.** Benjamin Howarth Thwaite, 37, Victoria-street, Liverpool.

6004. **Automatic platen applicable to divers systems of type-writers and electric printing telegraphs.** Francis Edward Suddard, Ars an der Mosel, Lothringen, Germany.

6031. **An improved system for transmitting electric currents.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (William Courtenay, United States.) (Complete specification.)

6032. **Improvements in switches for electric-light fixtures.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Joseph Hutchinson, United States.)

6050. **Improvements in alternate-current motors.** Otto Titus Bláthy and Max Déri, 28, Southampton-buildings, Chancery-lane, London.

6073. **Improvements in arc electric lamps.** James Eglington Anderson Gwynne and Rankin Kennedy, 11, Furnival-street, Holborn, London. (Complete specification.)

MARCH 22.

6078. **A hand electric generator or machine for firing explosive charges or igniting fuses, principally in mines.** Frederick Brown, 6, Livery-street, Birmingham.

6139. **Improvements in coating the interior of hollow vessels by electro-deposition.** Arthur Barrett, 4, South-street, Finsbury, London.

6100. **Barrel springs or covered wire for use on telephones, or as piano-wire or any other kind of musical instruments, in any thickness of half-round, square, or oval shape.** Joseph Baier, 3, Richmond-buildings, Dean-street, Soho, London.

6163. **Improvements in tanks or cells for electrolytical and other chemical purposes.** Heinrich Traun, trading under the firm of Harburger, Gummi-Kamm, and Co., 45, Southampton-buildings, Chancery-lane, London.

MARCH 23.

6170. **Improvements in apparatus for forming earthenware electric switches and the like.** Joseph Meir, 55, Market-street, Manchester.

6205. **Improvements in method of and apparatus for distributing and regulating the distribution of electricity for lighting and motive power, and other purposes.** Reginald Wood, 17, Gower-street, London.

6225. **Improvements in ground sockets for tubular posts for telegraphic and other purposes.** Siemens Brothers and Co., Limited, and Richard von Fischer-Truenfeld, 28, Southampton-buildings, Chancery-lane, London.

6233. **Improvements in electric clocks.** Edouardo Du Bois, Avondale, Earlsmead-road, South Tottenham, London.

6241. **Improvements in electricity meters or motive devices for measuring single and multiphase electric currents.** Thomas Duncan, 70, Chancery-lane, London. (Complete specification.)

6254. **Improvements in electric arc lamps.** Alfred Lyster Shepard, 45, Southampton-buildings, Chancery-lane, London.

MARCH 24.

6282. **Electrical fire or temperature alarm.** John Phillips, jun., and Thomas Corbett Lewis, Warren Chapeltown, near Sheffield.

6295. **Improvements in and relating to electric incandescent lamps.** Theodor Stober, 70, Mark-street, Manchester.

6306. **Improved electric current meter.** Sophus Emil Nielsen, 52, Chancery-lane, London.

MARCH 25.

6407. **Improved lamp and shade holder for incandescence lamps.** Herbert Luzerne Todd and Frederick Lake, 10 Laurence Pountney-lane, Cannon-street, London.

SPECIFICATIONS PUBLISHED.

1892.

4025. **Effecting electrical communication.** Miller.
6145. **Electric railway system.** Boynton.
6364. **Electric arc lamps.** Lake. (Wilbrant.)
6637. **Battery electrodes.** Heyl.
7466. **Electrical railway communication.** Shiels.
7655. **Electrical call, etc., apparatus.** Nunn.
8212. **Electric conductors, etc.** Smith and Wilson.
8268. **Electrical steering gear.** Grimston and Dykes.
9758. **Electric arc lamps.** E. E. and L. C. Beauvalet.
9941. **Electrical contacts.** Smeeton and Page.
11817. **Distributing telephonic currents.** Marinovitch and Szarvady.
22915. **Printing telegraphs.** Wise. (Buckingham.)
22931. **Printing, etc., telegraphs.** Wise. (Buckingham.)
24147. **Telegraph keys.** Bradford.

1893.

1561. **Electric motors.** Lake. (Lundell and another.)
1621. **Distributing alternating currents.** Bradley.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3 3/16
— Pref.	—	2 3/16
City of London	—	12¾
Electric Construction	10	4
Gatti's	—	5½
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4¼
London Electric Supply	5	1½
Metropolitan Electric Supply	—	6½
National Telephone	5	5¼
St. James'	—	8
Swan United	3½	3¼
Westminster Electric	—	5¾

NOTES.

Lighthouse Lenses.—Mr. Alan Brebner, B.Sc., in a paper published by the Institution of Civil Engineers, deals with the "Relative Powers of Lighthouse Lenses."

Lecture.—Last week Prof. Viriamu Jones, principal of Cardiff University College, lectured at the Guildhall, Brecon, on "The Velocity of Light" and "Magnetism and Magnetic Fields."

Institution.—The next meeting of the Institution will be held next Thursday, April 13, when a paper on "The Distribution of Power by Alternate-Current Motors," will be read by Mr. Albion T. Snell.

Royal Institution.—Prof. Dewar will begin a course of five lectures on "The Atmosphere;" and on Saturday, the 15th inst., Mr. James Swinburne will begin a course of three lectures on "Some Applications of Electricity to Chemistry."

Traction in Paris.—Permission has been granted to the Compagnie Générale des Omnibus to substitute mechanical traction for horse haulage on the lines from the Louvre to Saint-Cloud, from the Louvre to Sèvres, and from Sèvres to Versailles.

Vibration.—We have little to complain about even in Grosvenor-gardens over the underground railway in comparison to what is experienced in Hamilton, Canada, where the vibration of the trolley cars is said to have caused the plaster to fall off the walls of the buildings.

Paddington Electric Railway.—We understand that the promoters of this electric railway have decided to drop their application this session, the House of Commons Committee not caring to allow a recommittal of the Bill for the consideration of an alteration in the design.

What is an Engineer?—A correspondent of the *English Mechanic*, in answer to the question of how to become an engineer, says pithily in his last paragraph: "The simple answer to the question is, Read the conditions for getting a Whitworth scholarship, and get one—there is an engineer."

The Paris Jockey Club.—The rooms of this club have now for some time past been electrically lighted from plant installed on the premises. There are about 500 lamps of different candle-powers. The plant comprises Collet boilers, Willans engines, Rechniewski dynamos, and Worthington pumps.

Model Station.—The Orleans Railway Company, in its new Sceaux Station, now being constructed at the Médicis crossway, proposes to erect a model electric station. Not only will the buildings be lighted solely by electricity, but both the passenger and goods lifts, the cranes, and the turntables will be operated by electric power.

The Champs Elysees.—A proposal was brought before the last meeting of the Paris Municipality for the public lighting by electricity of the gardens of the Champs Elysées, and for the substitution of high-power gas lamps for those already in use on the Avenue. The suggestion was sent to the Third Commission for consideration.

Arc Lamp Charges.—The contracts for arc lighting in Philadelphia were thus divided: 1,363 lamps at 39 cents a night, 417 at 45 cents, 238 at 47 cents, 262 at 50 cents, and 250 at 55 cents, the higher figures of course being for the suburban districts. In New York there are 2,280 lamps at from 40 to 45 cents (1s. 8d. to 1s. 10½d.) per night.

Moths.—One curious result of the introduction of the electric light into Oxford has been, according to a provincial contemporary, to attract moths of very rare species to the brilliantly-lighted streets. One gentleman caught recently, in Broad-street, a specimen of the very rare Elephant Hawkmoth, doubtless attracted by the electric light.

Fire from Battery Acid.—A policeman last week was called to extinguish a fire in an attic at Manor-place, Sunderland, which had been caused by a vessel containing sulphuric acid for an electric battery bursting. The fumes were stifling, and the officer was almost choked before he could throw some buckets of water upon the burning floor and put out the flames.

Institution Picture.—Messrs. Barrauds inform us that the group photograph of the members of the Institution will shortly be taken out of print, so that those who desire a copy should send for it at once. One of these fine photographs, framed, containing portraits of over 500 members of the electrical engineering industry, can be seen in the window of this journal at Salisbury-court.

Lyons.—A small central station has been erected in one part of Lyons. The distribution is by bare overhead wires carried on insulating supports above the roofs. A 50-h.p. Pignet engine drive an Alioth dynamo of 250 amperes at 170 volts; there is a battery of Tudor accumulators as stand-by. The price is 10c. per hectowatt-hour (9½d. per trade unit). About a thousand lamps will be shortly lighted.

Journal.—The new *Journal* of the Institution contains the conclusion of the discussion of Dr. Fleming's paper on "Alternate-Current Transformers"; Mr. Mordey's paper on "Testing Alternators," and the discussion; and also two original communications—viz., "Notes on a Selenium Cell," by E. O. Walker, C.I.E.; and "A New Danger to which Underground Wires in India are Exposed," by C. V Luke, C.I.E.

City of London Electric Lighting.—We give to-day the statement of accounts to the 31st December, 1892, of the City of London Electric Lighting Company. It will be noticed that the revenue account is for a period of six months only. The meeting is to be held on the 13th prox. The chairman will in his statement give much fuller details of the progress and position of the company than is possible in the report.

Cost of Electric Cooking.—Dr. A. T. Schofield, at a recent lecture before the Sanitary Institute, dealt with the cost of the current for cooking. The stove showed the best results as a cooking utensil, as the heat is well applied and economised, although the amount of current consumed makes it costly. It was stated that a small stove required about 12 amperes of current per hour—equivalent to an expenditure of 3½d. to 4d.—but that large sizes were much more economical.

An Exhibition of Progress.—The Société Nationale des Sciences et des Arts Industriels, which instituted exhibitions in Paris in 1886 and in 1890, is now organising at the Palais de l'Industrie an international exhibition of progress to be opened in July and to be closed in December next. The exhibition will represent the progress made in instruction, metallurgy, engineering, electricity, locomotion, hygiene, etc. The offices of the Société Nationale are at 3, Rue des Pyramides, Paris.

Measuring Instruments.—Voltmeters and ammeters are required for every installation, and those made by Messrs. Hodges and Todd, whose price-list has just reached us, are evidently appreciated by electrical engineers, as the firm have had to extend their machinery. The voltmeters are specially wound so that the temperature errors are negligible, and both pressure and current instruments are sensitive over a wide range. Battery-cell testers for minute variations of pressure are illustrated, as well as portable instruments of both kinds.

Lead Coating to Steel.—According to the *Polytechnisches Notizblatt*, articles of steel and iron can be protected against rust by coating them electrolytically with peroxide of lead. A satisfactory coating can, it is said, be obtained in 20 minutes, and is perfectly proof against atmospheric influences. As the whole operation is conducted at ordinary temperature, the temper of steel articles is unaffected by it. This is a novel process, but it does not appear how the coating of lead wears in actual work.

Train-Lighting Patents.—With reference to our note on train-lighting in Ireland Mr. Evelyn-Liardet writes to claim the invention of lighting trains from accumulators placed in the guard's van and charged from a dynamo driven from the axle of the guard's van, and that the credit of the invention should be given where due, instead of to engineers "who work on other people's inventions." We have no opinion ourselves to give on the matter. As we have said before, the law courts only can thoroughly settle such claims for controlling patents.

Books Received.—We have received a copy of "Alternating Currents," an analytical and graphical treatment for students and engineers, by Frederick Bedell, PhD., and Albert Cushing Crehore, Ph.D., instructors in physics at Cornell University; publishers, W. J. Johnston and Co., New York, and Whittaker and Co., London. Also "Die Berechnung Elektrischer Leitungsnetze in Theorie und Praxis," by Jos. Herzog and C. P. Feldmann; and "Anordnung und Bemessung Elektrischer Leitungen," by C. Hochenegg, both published by Julius Springer, Berlin.

Charging Batteries with Alternating Currents. On the 20th ult. experiments were made at the Frankfort Accumulator Works in the way of charging secondary batteries direct from an alternator made by Messrs. Brown, Boveri, and Co. The arrangement is said to be due to M. Pollak. In referring to this statement, quoted from a Frankfort daily paper, the *Electrotechnische Zeitschrift* states that it will endeavour to ascertain what really were the facts, and mentions, as is now well known, that this is not the first time that accumulators have been charged by alternating current.

Traction in Vienna.—An electric railway is projected in Vienna, from the Grossmarkethalle to the suburb Schweehat, with a branch to the racecourse in Freudenau. The chairman of the Vienna Tramway Company remarked at the general meeting held last week that the company was disposed to introduce, either on the whole or on part of its lines, a mechanical motor which would drive the cars at a higher speed than at present, and thus allow of the traffic being properly handled. The New Vienna Tramway Company proposes to adopt experimentally the Siemens and Halske slotted-conduit system.

Spread of the Telephone.—An important invention in connection with the Telephonic News, which circulates news to subscribers by telephone, says a Vienna newspaper correspondent, has been successfully tried at Pesth by a combination of wires. A telephoned report was distinctly heard at the same time by hundreds of persons in town many miles apart, such as Vienna, Gratz, Prague, and Trieste. The inventor asserts that had there been half a million subscribers spread all over Europe they all could have heard what one official spoke into the apparatus at the central office, and that distance and number of subscribers made no difference.

Telegraph Pioneers in Australia.—Colonel E. C. Cracknell, late Superintendent of Telegraphs in New South Wales, whose death was recently recorded, was one of the pioneers of telegraphy in Australia. When Sir George Airey in 1855 offered the appointment of Postmaster-General and Superintendent of Telegraphs in South Australia to Mr. Charles Todd, Mr. Cracknell was selected as assistant. The first Government telegraph line was from Adelaide to Port Adelaide. Mr. Todd afterwards mapped out a scheme for connecting Melbourne and Adelaide, and Mr. Cracknell laid down the South Australian section. In 1857 Mr. Cracknell was appointed superintendent of telegraphs in New South Wales, a position he held to the time of his death.

Concrete Slabs.—The Institution of Civil Engineers publish a short but useful article on the "Strength of Concrete Slabs," by Sidney R. Lowcock. The paper gives the results of a series of tests made by the author to determine the strength of cement concrete slabs made with varying proportions of cement, in order to ascertain their suitability for covering an underground trench exposed to ordinary road traffic. This investigation will have interest to engineers having to prepare concrete conduits. The slabs were made of Portland cement and ground clinker from destructors. The tensile strength was 665lb. per square inch. A rectangular block of concrete, 6¾in. by 3¼in. by 4in., cut from a block and tested for crushing resistance, broke down at 1,120lb. per square inch. Other results are given.

Lampposts at Bray.—Reference has been made more than once in these columns to the unusual height of the arc pillars recently erected in Bray by the late Mr. J. E. H. Gordon. It was considered that by mounting the lamps at a distance of 35ft. from the ground the light would be more equally and uniformly distributed over the intermediate space between each lamp. Practice, however, has proved this to be a mistake, and at a meeting of the Township Commissioners, held on the 3rd inst., we notice a letter was read from Mr. J. D. A. Norris, who wrote on behalf of Messrs. J. E. H. Gordon and Co., contractors, asking if the Commissioners would have any objection to the lowering of the arc lights to within 25ft. of the ground. The Commissioners decided not to raise any objection to reducing the height of the pillars, which are to be reduced accordingly.

Ediswan Catalogues.—It is not possible to compare incandescent lamp catalogues issued by rival firms, because as yet there is only one, and even when the lamp patents expire it is doubtful whether for some time to come any other makers will have such a multitudinous array of lamps to offer as are shown in the new list just published by the Edison and Swan United Electric Light Company, Limited. The previous very complete catalogues are quite surpassed by this; and anyone who desires a lamp for purposes of the most out-of-the-way description will probably find particulars therein of what he requires, or of the readiness and ability to supply same, whether it be for illuminating the interior of a room, a stomach, or a gun. Similar catalogues—though perhaps a little less comprehensive—are also to hand showing details of installations, fittings, and measuring instruments. These lists are very clearly printed and copiously illustrated.

Chamber of Commerce.—The London Chamber of Commerce forward us certain forms to be filled by members for remarks on railway rates, marking merchandise, etc. The employment department continues to extend its service, and as may be observed from the March number of the *Chamber of Commerce Journal* the list of applications is now subdivided under the following heads: Junior Clerks, Shorthand Clerks, Correspondents, Book-keepers, General Clerks, Shipping Clerks, Secretaries, Managers, and Accountants, Salesmen or Travellers, and Miscellaneous.

At the present time there are a number of applicants for employment on the register. The secretary mentions that the Chamber of Commerce Board-room may be obtained for public meetings in the City. The annual dinner of the Chamber will be held at the Hotel Metrôpole on April 22, when Sir John Lubbock will take the chair, the principal guest being the Right Hon. A. J. Mundella, M.P. A number of other prominent men will be present.

Lamp-Trimming.—At the lighting of Bray, where arc lamps of the abnormal height of 35ft. are used, the trimmers employ a telescopic ladder designed, we believe, by Mr. Brockie. The ladder itself can be extended, and the whole is mounted on a four-wheeled carriage, on which is a box for carbons and tools. It can be drawn by one man, but for the sake of convenience shafts are attached so that it can be drawn more quickly by a pony. In the City of London the type of lamps are two: one, of the more ancient type, gives an interesting exhibition to passers-by in Fleet-street. The trimmer arrives with a short ladder, mounts a certain distance therewith, and then, taking out some iron or other pegs from his pocket, inserts these into holes in the lamppost, and so climbs to the lamp. In other newer and more convenient types, a crank-handle at the foot of the lamp controls a lever which throws out a whole set of ornamental projections on the lamppost. These usually lie flat, but by turning the key they are thrown outwards; by a still later addition this movement also short-circuits the switch, making the lamp safe to handle. The lamps that are found satisfactory in Berlin and elsewhere which are lowered by cords, have not apparently found much favour in this country for public lighting—a more solid and stable connection being preferred at the expense of a little agility on the part of the trimmer.

Police Pocket Telephones.—One of the neatest articles that has recently been added to the equipment of some of the Newcastle policemen, says the *Newcastle Chronicle*, is the pocket telephone. It is handy and light, consists of a combined mouthpiece and earpiece, has about a foot or more of wire attached, and there is in addition an affixing pin and a small key. This apparatus is to be used by the officers in connection with the fire lamps placed at various parts of the city. Instead of breaking the pane of glass in case of a fire breaking out in the neighbourhood—as an ordinary individual would do—the policeman opens the door with his key, places the affixing pin in a socket provided for it in the lamp, and is in immediate communication with the fire brigade. He can tell them in an instant what the nature of the conflagration is, and what appliances are likely to be required. The pocket telephone, however, and the fire lamps can be utilised for other purposes. A constable, for instance, in the case of a robbery or murder, or in the matter of a burst water-pipe threatening to severely damage property, could immediately signal for help, for the fire station in Westgate immediately adjoins the police station, and communication from one to the other could be instantly made. The telephone, which can easily be carried in the coat pocket, is, it will be seen, of great practical use, and the idea of providing policemen stationed in the vicinity of fire lamps with it is a valuable one.

Accumulator Cars in Paris.—In our issue of September 30 last we described the accumulator cars which have been introduced by the Compagnie des Tramways de Paris, and which now exclusively deal with the passenger traffic on the lines from Saint-Denis to the Madeleine, and from Saint-Denis to the Opéra. At the commencement of the service in June last, horse cars were operated in conjunction with the electric cars, but the former have now been withdrawn. M. Max de Nansouty considers this application not as an experiment, but as a real industrial undertaking. The total length of the two lines electrically worked is about 11 miles, and this is shortly to be increased to 14 miles by the starting of cars on the line from the Saint-Ouen Town Hall to Neuilly. The receipts per car mile run have largely increased, and, says M. de Nansouty, owing to the satisfactory results obtained, the tramway company has decided to extend electric traction to its other lines. With this object in view M. Dupont, director, and M. Broca, manager of the company, have, with the assistance of M. Potier, devised a type of secondary battery car which they state will mark a step in advance, and which will allow of the recuperation on declines of a portion of the energy due to the force of gravity and storing it in the cells. Tests in this direction have yielded good results and cars are now being built. This method is, however, not new, having been suggested in the United States some time ago.

Mr. Kapp's Book on Dynamos.—The electrical world has been waiting for some time for Mr. Gisbert Kapp's book on "Dynamos, Alternators, and Transformers," which is now published, from the office of this journal, by Messrs. Biggs and Co., price 10s. 6d. The aim of this book is to give the builders and designers of dynamos and transformers the exact practical information they require for the proper construction of machines. It is copiously illustrated, and the use of high mathematics and complicated methods have been avoided, though, of course, to avoid mathematics altogether was impossible in such a book. The mathematics are restricted, however, within such limits as will enable the engineering student or the average practical engineer who knows little about electricity to find exactly what he requires in order to build practical apparatus. The book comprises 18 chapters (490 pages), dealing with: Definitions, measurement, magnetic field, action of current on magnet; electro-magnets and solenoids, properties of iron, Hopkinson's method; induced E.M.F.; closed-coil, bi-polar or multi-polar winding; armatures, field magnets, commutation; large dynamos; eddy currents, methods of testing. Well-known types of dynamos are described and illustrated; alternators are then discussed, and a chapter is given to the design and construction of transformers. Details of all the machines exhibited at the Crystal Palace are given, and the book concludes with a full index.

Electric Power for Driving Tools.—The economy of electric power over steam-engines in engineering shops where there is a variety of tools only used intermittently, is not so readily understood as it should be. A case, however, where considerable saving has been effected by adopting electricity as the motive power, is to be found in the electrical workshops of the Compagnie des Chemins de Fer du Nord, at Saint Ouen-les-Docks. In this instance the initiative in the matter was taken by M. Sartiaux, and the electrical supply serves to operate lathes of different sizes, drilling and planing machines, ventilators, saws, and grindstones. Most of these are only used intermittently, and it was therefore thought that electricity would be the most economical power to drive them. This supposition turned out to be correct, apart from the fact that as the new workshops were partly built from the planks of the building which had formerly formed the old maritime station at Calais, it was almost out of the question to think of putting up shafting and belting. The installation, which was started in October of last year, has been entirely satisfactory. Since the commencement, the average daily consumption of current has been 11 kilowatt-hours, the current being supplied by the Société d'Eclairage et de Force at the rate of 0·38f. (3¾d.) per kilowatt-hour. It will be evident that the cost per day for current only amounted to 4·18f., or, say, 3s. 5d. To this must of course be added the expense for maintenance of the motors, cost of oil, attendance, renewal of brushes, etc., and which, according to the company's books, represent a sum of 30f. per month, or 1f. per day. This brings up the total cost to 5·18f., or 4s. 2½d. a day. This shows considerable economy over the expenses incurred in the old shops, where the power was furnished by a gas-engine. In this case the average expenses per month amounted to 415f. (£16. 12s.), and comprised the supply of gas and water, cotton waste, repairs, and attendance, or a daily expenditure of a trifle over 13f. (10s. 6d.).

Heilmann Electric Locomotive.—The system of propulsion originally intended comprised the application of electromotors to each axle in the train, the current being supplied by a steam dynamo on the locomotive, which itself was to be propelled by electromotors. In a paper recently published by M. Heilmann in the *Bulletin de la Société Industrielle de Mulhouse*, the author states that of this system only the locomotive has for the present been retained, and the author gives illustrations and particulars of its construction. The boiler and the generating machinery are carried on a frame, 53ft. long, which rests on two eight-wheel bogies. On either side of the boiler are coal-bunkers having a total capacity of six tons, and water-tanks for 2,200 gallons. The total power of the locomotive is from 600 h.p. to 800 h.p., and its weight, when in service, is 42 tons. The boiler is of the Lenz type; length over all, 26ft.; diameter, 6ft. 4in.; grate surface, 24·5 square feet; heating surface of firebox, 200 square feet; heating surface of tubes, 1,400 square feet. The engine and generating dynamo are carried in front, and a small steam dynamo is used for excitation. The main engine is compound, with the cylinders in line, and crankshaft between them. The cranks are set 180deg. apart, so as to obtain balance between the running parts. The cylinders are 16¾in. and 25⅝in. in diameter, the stroke being 12in. The brake horse-power at 300 revolutions per minute is 600, and at 500 revolutions 800 h.p. Weight of engine, 5 tons 3cwt. The generating dynamo is coupled direct to the engine shaft, and is a six-pole machine with ring armature wound for 400 volts and 1,025 amperes, at 300 revolutions per minute. The diameter of the armature is 49in. Each of the eight axles are provided with a four-pole motor of the iron-clad type; diameter of armature, 25½in.; diameter of driving wheels, 45½in. Maximum speed of motors, 560 revolutions per minute. Switches are provided for placing the right motors in series when running up an incline.

Metallurgical Display.—The Sheffield Technical School Metallurgical Society held a *conversazione* last week at the Technical School, which was voted a very great success. Mr. R. A. Hadfield is the president this year, and it was largely owing to his suggestions that so large and interesting a collection of exhibits was made. The rooms were ornamented with flags, banners, and other devices, and the pleasing effect was further heightened by the magnificent electric light installation provided by Mr. Scott Anderson and his assistants. The entrance to it from the old laboratory was through an arch composed of a huge locomotive driving-wheel tyre, lent by Messrs. Brown, Bayley, for the occasion. The tyre was draped in ivy, and hung with varied electric lights. The refreshment-room was richly decorated with flowers and numerous electric lamps of different design. Mr. Scott Anderson has erected complete electric welding plants in operation—both Benardos and Thomson-Houston systems, this being the first public exhibition of the kind in the town. An electric furnace was also shown working, taking 300 amperes of current, in which were smelted copper, steel, chromium, etc.; the latter is a very refractory metal, and is never fused in a coke furnace. These operations were watched throughout with great attention and interest, more particularly by those engaged in the heavy steel and iron trade. Electric cooking and heating appliances were also in operation, as well as a motor showing the possibilities of transmission of power. The lighting of the refreshment-room was very much admired, being draped and ornamented throughout with fairy lamps, and lamps of 32 c.p. were also used. Although the whole installation was for one night only, and put down in a temporary fashion, not a single hitch occurred. Mr. Preston, of the National Telephone Company, arranged telephones in the school so that a dozen visitors at a time were enabled to hear music from theatres in London, Manchester, and Newcastle. Electric gilding was also shown in action. So popular was the exhibition that regret was freely expressed that it could not be kept open for a longer period.

Underground Wiring for Tramways. — The opinion of Mr. Pearson, who is electrical engineer to the West End street railway of Boston, is worth much from point of view of actual experience, on the effect of the current on return feeders. He says: "In small systems where there are few cars running, the ordinary method of returning the current through the rails and supplementary wire will be sufficient unless the distance is great; but on large roads where the traffic is heavy more return grounds than have been used heretofore will have to be installed. We found it so in Boston, and from a lack of return feeders a great deal of electrolytic action was caused in our supplementary wire. We are now putting up a large amount of overhead copper for return grounds. I do not think it possible to put it underground, as it will corrode and rust away. There is no advantage in using iron, as the conductivity is only one-seventh that of copper. Originally we ran the positive current through the trolley wire, but we found that the action on the supplementary wires was too great, and we changed it and put the negative through the trolley wire. I do not imagine there will be much less effect, as it merely transfers the action to another point. I do not recall any particular trouble with water-pipes; but, naturally, if you have a large volume of current going through the earth, it will take hold of a water-pipe or a gas-pipe, or any other pipe, and there will be an electrolytic action set up. In any large railway system, if the attempt is made to use the earth for return ground by putting in ground plates in driven walls, or by putting them in the rivers, and the return current is not provided with a good metallic circuit, it seems to me that the current must inevitably injure the water-pipes and all other pipes. The current when it leaves the car goes into the ground, and taking a water-pipe may go a mile on that pipe, then leave it for a better conductor; the result being that the pipe will be corroded at this latter point." Using iron rails with copper connections forms an electrolytic element, and corrosion occurs. This condition obtains, however large the joint is made. It is not practical to use old rails for conductors. Worn-out steel cables soon corrode away. Another point is which current should return by earth. The usual construction with ground plates makes the trolley wire and supplementary wires along the route positive, and the ground plate at the station negative. This is not a good arrangement, as the line and ground plates along the route are then corroded away, while the station plate is uninjured. If the trolley and line plates are made negative, corrosion will be confined to the station plate, which can easily be replaced.

THE TRAINING OF ELECTRICAL ENGINEERS.

The technical schools and scientific colleges are manufacturers of habits—habits of thought and of action in the young men they are paid to train. These young men are to become electrical engineers in a practical world. We wish to ask the question: how far are the schools and colleges which teach electricity and magnetism, or electrical engineering, complying with the demand of electrical engineers in actual life for the production of assistants with the requisite knowledge. Imagine a Government or publicly-paid factory producing material—habits of cloth, if you will—who would insist month after month and year after year in producing clothes of a certain cut and texture which very few persons require. They may produce ancient embroidered clothes of a prehistoric cut in great quantity, they may produce garments of a more modern cut but of flimsy and unusable material, made of gauze, and covered with beautiful hieroglyphics and frippery of lace and other adornments; but if no one wants these sort of things, if they are produced for the mere amusement and delectation of the makers, what use do they serve? Would they not do better to be constantly enquiring exactly what were the articles that the future users really require, instead of maintaining a large machinery for old-timed and picturesque but useless products. The same question may be asked of the training colleges.

We do not mean to say that all technical colleges produce nothing useful. Far from it; a move has certainly been made within the last few years, especially since the institution of the City Guilds classes, for the establishment of courses that would produce really useful material in the young men they turn out in such quantities. But are they yet quite successful? Have they, indeed, taken the utmost care to see that while training young minds they were producing the material that was wanted? Have the authorities of the schools and colleges systematically and regularly asked of the future employers of these young men they are paid such high salaries to train, whether the results of their training were what are required? Have they always sought to ask the practical men for guidance in the direction of the so-called technical teaching? Well, if the truth be told, we fear not. If the practical men, the engineers, heads of firms, and employers of technical labour are asked, we fear the answer is not always a very flattering testimony to the value of the technical training. Though much has been done in the way of technical training, more yet requires to be accomplished.

The general training or education of the young engineer will bear in three directions. There is the general education, there is the special technical education, and there is the commercial knowledge of business life and its ways. The latter is that to which, if the student is not destined for pure literary or scientific work, the other training eventually tends, and it has therefore a wide, over-reaching importance.

The general education, of course, is the affair of the ordinary schools, and here, we fear, even far worse than in the technical schools, shadows, and abstractions, and teachers' knowledge, have long held sway to the exclusion of really useful work. The whole science of education is in a lamentably backward state. Compared with the progress in the sciences of mechanics and electricity, the science of imparting the greatest knowledge, and of obtaining the greatest intellectual activity—in a word, education, is in many cases in a very backward condition.

The boy, on leaving school, should be able to write well, handwriting and composition included. Given a certain subject, he should be able to express his thoughts, describe any situation, or write a paper with accurate expression and legible writing. Not all who leave school can do so much as this. He should know something really about bookkeeping—actual accounts, and not abstract problems upon nothing in particular, that no one in the world cares two pins about, but really useful calculations that may at least serve him in good stead. He certainly ought to know at least two languages; and by knowing them should be meant, not a useless jumble of abstract grammar and utter nonsensical expressions that no one ever heard of out of an examination: but he should be able to speak, understand, read, and write them well. It can be done. The schoolboy should be able to draw a sketch and trace a drawing. Other things in the same way. The pabulum of teaching requires rearranging year after year, and should be taught by teachers who have lived in the outside life, and not only passed their existence in schools and colleges.

In technical work, when the student comes to learn this, there are certain things at least he ought to be able to do. What are these basically essential things? Ask the practical electrical engineer, and he will tell you. The youth should be able to take real tests—tests of cables, of wiring, of dynamos, of engines—so that at least he might be soon useful if he does not know Lenz's law. He ought to know how to run an engine and dynamo and accumulators, so that at least he would be thus useful—if his technical training did not enable him to calculate hysteresis. He ought to know how to make a good tracing, a clean drawing and a useful drawing—not of examples, but of real pieces of machinery. His calculations in mathematics ought to be always of some useful purpose; and this should be specially insisted on—he ought to be taught just those calculations which are used by engineers in actual engineering operations first, so that at least he could do these. Then add the finery of high mathematics afterwards if you like.

A case in point occurs to our memory. A very well-known professor in a very high position in a very high-class technical provincial school, had occasion to require a girder in this school. Capital chance for a calculation. He entered into very careful calculations, formulæ and calculus abounded, and the girder was designed after much cogitation and excitement. But, in order to be sure that no mistake had occurred, before actually putting the risk on this same beam, a consulting engineer was called in to corroborate the calculations. He came, measured, consulted his pocket-book, and gave the correct measurement off the reel, so to speak, pocketing his engineer's fee, remarking to a bystander that there was not an assistant in his office who could not have calculated this piece of work in a couple of minutes. Theory *versus* practice—it is the same tale. We are urging for a constant readjustment of theory by advice of the practical men, and a commencement of the technical training by the use of practical methods as used by engineers in actual engineering.

The young engineer in training should learn something of the actual examples of the calculation of conductors, *as they are calculated by engineers*; afterwards, if you will, finer methods may be discussed. He should know something of specifications—actual specifications: house, factory, ship, and town installations. He should be able to lay out simple work and give directions; design switchboards for certain purposes; test dynamos as they are tested in actual factories; and know whether the tests taught were those of practice or merely those of precise theory not so much in use. He should know something of patents, and the routine and law which regulate them. If he knows these sort of things he is some use—which is more than can be said for all students when they leave the colleges—to guard ourselves, we had better say some colleges.

But of all the knowledge and training that is required, the business or commercial part, though most difficult to teach, is certainly the most important. The ways of looking at material and work in the workshop and in the college are radically different. They cannot be the same; but the tendency to look at the work from the purely teachers' or scientific point of view ought to be continually corrected by reference to practical business considerations. The cost of materials and the best ways to use it to best advantage are susceptible of some treatment. The management of works, organisation of factory and men, negotiations; the part taken by the Board of Trade, the local board, and municipal authorities in helping or restricting engineering work; the outlooks in various branches of industry and various countries; the cultivation not only of knowledge but sharpness and the sense of responsibility—all these modify, or should modify, the young engineer's training.

Passed through a technical college, the life
electrical engineer at the works

great importance. Given a good mechanical and some business training, it is doubtful whether most electrical firms would not rather take their young men untainted with electrics. But suppose they know what we have suggested, and have passed a good course of lectures, laboratory, and text-books—once passed into the works their technical training resolves itself.

A good course would be such as this: Three years at least apprenticeship. The first six months or even first year in the fitting-shop and assembling-room. Promoted to the planing-shop, the student will manage tools, set off work, and work to drawings. Then he may go to the foundry and spend a few months in learning to mould. After that, small and careful work, brasswork. Next, if he can, pattern-making and woodwork. He may then go to the armature winding; meanwhile doing testing and some outside work on installations. He should erect and run engines, learn to manage boilers and dynamos at work. Then a year in the drawing office will be a useful finish. He can here, perhaps, learn to design dynamos, and then take in hand gradually on his own account the commingled business and engineering, which will lead him to an honoured place in the profession.

We have thought it might be well to ask the heads of electrical engineering firms or companies exactly what it is that they would desire in the young men who come to them for employment. We have received the following answers, and shall probably have some others, which we think it will be interesting to publish.

The first is, from Messrs. Crompton and Co., Limited, as follows: "In reply to yours of March 21, the question that you put to us is a very easy one for us to answer. One of the roads into the electrical profession is through our works. We take a certain number of pupils, about 10 every year, and train them for three years. We prefer that they should come to us having had first a sound general education, including a thorough knowledge of one, or possibly two, modern languages, they should also have studied electricity, applied chemistry, mechanics, and the other modern side courses, of which there are now so many in London and the provincial towns. If a boy leaves school at 17 and studies in this manner for two years he is ready to come to us, but we often advise intending pupils to spend a year and a half or two years in a mechanical engineering workshop to learn pure mechanical engineering, in which case they would not come to us till they were 21. We prefer this, as we do not think the practical part of the work is so thoroughly appreciated by the pupil until he reaches this age. After a three-year course, the last of which is generally spent in positions involving considerable responsibility on contract work, we find that the young man, who will then be 24 years of age, is very fit to take a good post as an electrical engineer. I think the main point on which our views differ from others is, we do not like to take pupils so young as is very often the case."

Mr. W. B. Esson sends the following practical conclusion: "It seems to me that the proper place to train men for the technical staff of a manufactory is the manufactory itself, where they can see production carried on as a means to an end, the end being profits. In a great many ways the technical college unfits men for the business of life, and it is engaged in producing an article for which there is little or no demand in the commercial world. When the student enters on practical work and the real business of life commences, much of what he has learnt has to be unlearnt, and there is a rude awakening from his laboratory dreams of big salaries. I find that men from technical colleges are mostly useless, because their theoretical notions are unguided by commercial considerations, of which they are without knowledge. After all, production is a compromise between theoretical perfection and practical utility, and nowhere can a knowledge of the lines upon which the compromise is to be effected be gained save in the factory. The men who have risen, and the men who always will rise, are those who, during their apprenticeship, had to get their theoretical training as best they could after their day's work was over; and considered as a means of teaching in this way, I have no words of praise high enough for the technical night school. But to spend years at a college I consider a mistake, save for the very few who, having real grit in them, succeed not because of the training, but in spite of it."

We hope eventually to publish other opinions on this important subject.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 305.)

ARMATURE WINDING.

Armatures can be divided into three types: (*a*) drum, (*b*) cylinder, or long ring, (*c*) disc, or short ring, as in the case of field-magnet winding. Each method of armature winding has its peculiar advantage, and is used for certain cases.

(*a*) *Drum Winding.*—A drum-wound armature is of the shape, as the name implies, of a solid cylinder, the wire passing lengthwise round the surface of the drum-shaped core. The length of wire that passes across the two end faces of the drum is evidently wasted, so far as cutting lines of force is concerned, so that the useful length of the armature wire or conductor is measured by the length of the drum; one length of wire along the drum is called an "armature conductor." These conductors are fixed around the periphery of the drum core, diametrically opposite conductors being joined together by an "end connection" at the back end, the other two ends of the pair being connected to two contiguous segments of the commutator. The beginning of the next pair is joined on to the same segment that the end of the first pair is joined to, and so on. Therefore it follows that all the conductors are in series, so that these front connections on the commutator are similar to what is shown in Fig. 19, and by imagining the wire to be fixed lengthwise round a drum, instead of being coiled several times round an annular ring, we can obtain an idea of the connections of drum winding. To avoid the wires crossing or overlapping each other at either end, the end connections take a flat spiral form, semicircular strips of varying diameters being used for the several conductors.

Since the length of the drum is large compared with the diameter, therefore the useful length, or the conductor, is large compared with the wasteful part, represented by the end connections, back and front. The great advantage of drum winding is owing to this, because, for similar total length of wire, this method of winding will produce a greater E.M.F. than any of the other methods of winding the waste wire being less. Drum armatures are the ones mostly used for low-pressure dynamos, such as running incandescent lamps in parallel. They are ill-adapted, however, for machines giving high pressure, because, owing to the numerous end connections, they are very difficult to wind and insulate properly, so that the risks of short circuits taking place are great, for any two wires would have a fairly high difference of potential betwen them, and there is no room to provide suitable insulation. When heavy currents are required at a constant pressure, these armature conductors pass from a wire into a massive bar. The bars are sometimes made of solid copper, and sometimes built up of a number of copper strands, each strand being first insulated by varnish or any other suitable stuff. The bar is then twisted in the centre and subjected to great pressure, so as to make it as compact and solid as possible. The object of making the bar in strands like this is to kill the "eddy currents," which would circulate in a solid mass of copper. The direction in which eddy currents circulate is at right angles to the true or main current, so that by dividing the bar lengthwise, their circuit is broken. Some makers build their armature bars up by putting insulated strips together. Bars are insulated by cotton, tape, varnish, etc., and often separated by air-gaps; this latter plan has great merit, for there is no better insulator than dry air, and the ventilation is excellent, because the bars are exposed to the air. End connections are mostly soldered on, but sometimes, particularly in continental practice, they are screwed on. This latter plan is of immense advantage when the bars have to be taken out or in any way interfered with, but it can hardly be called as safe and sound a job as soldering. It the armature core were made of a solid mass of iron, the same trouble with eddy currents would arise as would with the bars, and to a very much greater extent, so that the core must be built up with a number of thin discs of very soft iron. Each disc is varnished over to insulate it from its neighbours, and the whole compressed and held in position by two stout end plates or washers, screwed on the spindle of the core. The armature bars are driven round by being let into slots cut lengthwise in the core, the bars are kept in their position by winding steel wire round them and the core, a layer of mica being put between the bar and the binding wire to insulate the two. The binding is put on in belts, or bands, each having from 10 to 30 turns, and being a distance of 1in. to 2in. apart, according to the size of the armature; the binding wire is then wiped over with solder. This binding wire naturally must be very thin, so as not to take up any room; as a rule there is only about a quarter of a centimetre air-space left between the binding wire and the pole-pieces, between which the armature revolves.

(*b*) *Cylinder, or Long Ring, Winding.*—For this method of winding a broad ring is required, the winding being round the annular body of the ring; hence as much wire passes through the inside of the ring as passes outside, and all the wire passing inside the ring is not only useless, but highly detrimental, because it produces a counter E.M.F. through cutting the lines of force that leak across the ring. The armature core is built up with a number of thin soft iron discs of a ring shape, the core being driven by a gunmetal spider, which is keyed to the shaft. This is very different to a drum core, this latter consisting of discs forming a solid cylinder, through whose centre the shaft passes, while the former constitute a hollow cylinder, having considerable annular depth, and free from iron in its interior, not reckoning the driving shaft, from which it is separated by a considerable air-space. These armatures are suitable for high-pressure machines, such as arc-lighting dynamos. They are easy of construction, easy to repair, and can be well insulated, but their efficiency is low compared to the drum.

(*c*) *Disc, or Short Ring, Winding.*—This kind of winding is mostly met with in alternate-current machines, where the magnets are arranged in two circles, the disc armature revolving between; by this arrangement the opposing poles are brought very near to each other on account of the thinness of the disc. Another arrangement is to have the armature mounted so as to revolve within a circle of magnet poles that project radially inwards from a circular yoke, in which case the pole-pieces are made alternately north and south. The core takes the form of a kind of wheel, the armature wire being wound on bobbins placed round the periphery of the wheel core, the number of bobbins corresponding with the number of north or south poles. Instead of bobbins filled with wire, the winding may be in the form of copper ribbon wound on "formers." The two ends of the winding wire are led to two collecting rings on the shaft.

Closed Coils and Open Coils.—So far, only armatures of the closed-coil type have been mentioned, such as is shown in Fig. 19. These are either of the drum or ring wound pattern, and are found in shunt and compound-wound dynamos, suitable for low and constant pressure work, such as running incandescent lamps in parallel. Alternating-current machines giving high pressures also have the coils joined up in series, so as to make one continuous circuit or closed coil.

An open-coil armature signifies one in which each coil or set of coils is separately connected to two diametrically opposite segments of the commutator, so that when the two brushes are resting on these two segments they collect current only from that one coil or set of coils, all the others being out of action; this being so, it is evident that the brushes must collect the current from the coil when it is in its most active position, and it is further evident that this position is when the coil is lying parallel with the magnetic field, or in a horizontal position—therefore the brushes of an open-coil armature must be at the ends of a horizontal diameter, or at right angles to what they would be in a closed-coil armature. There is no necessity, however, to restrict the collection of the current to one set of coils, because those coils which lie next to the horizontal-placed coil are cutting the magnetic field almost at as great a rate, and this can be utilised with advantage; it is customary, therefore, to allow the brushes to make contact with a pair of coils at the same time, when this pair is passing through the most active position, one set just coming into the position of maximum action, and the other set just going out. Open-coil armatures are used in series-wound dynamos giving continuous currents. These dynamo are made for high pressure and constant current, such as for running arc lamps in series with a pressure of, perhaps, 2,000 volts, and a current of 10 amperes.

Owing to the high pressure generated by the machine, and the fact that the current is collected at the point of maximum activity of the coils, it is impossible to use a commutator built up with mica-insulated segments such as is found in low-pressure dynamos, because the terrible sparking would quickly burn up and ruin the insulation and the segments themselves. It is necessary then to have the segments, which are few in number, insulated from each other by air-gaps. One great disadvantage of the open-coil armature is that the current is somewhat discontinuous, owing to the very small number of coils employed on the armature.

A closed-coil armature may have 50 conductors, each half of them being in series, and the two halves then put in parallel through the brushes, as already explained, but in an open-coil armature there may not be more than four or eight coils. The open-coil armatures may be built in a drum, ring, or disc form, but those of the ring form are more usual.

The above only gives a very brief outline of the classification and uses of the various kinds of armatures, and therefore only a few of the most important points have been dealt with.

(To be continued.)

UNDERGROUND ELECTRIC MAINS IN PARIS.

It is, perhaps, hardly necessary to remind our readers that the public and private electric lighting of Paris has been arranged by the municipal authority according to various districts or "secteurs"—in a somewhat similar fashion to the way in which London has been parcelled out.

Details concerning the system of underground mains adopted in one of these districts have just been published in *L'Electricien*, from whose pages we abstract the following particulars, embodying also illustrations that serve to explain the facts.

The central station which generates the current of electric energy for this section—which is known as the Secteur des Champs-Elysées—is situated on the banks of the Seine upon a plot of land at the corner of the Rue de Villiers, separating the communal territory of Levallois and Neuilly. The mains are carried along the Rue de Villiers for a distance of some 1,600 yards, or nearly a mile, reaching the city through the Porte de Villiers. Alternating currents at a pressure of 3,000 volts are employed, with transformers at each house or group of houses served.

The mains are concentric in form, cased with lead and iron strip armour, on the system of Berthoud and Borel, and manufactured by the Société des Anciens Establissement Cail. They are made in lengths of 100 to 200 yards—according to their section—and conveyed from the workshops or stores upon reels; the latter are each mounted upon a flat-bottomed truck or waggon by means of a strong plate pivoting on a platform so that a rotation in a horizontal plane is given to the reel. The workmen engaged in laying the mains can therefore easily draw off the lengths from the reels by drawing up the waggon against the pavement in which the trench is excavated for placing the mains. A layer of sand, a foot or so thick, is prepar[illegible] of the trench for the cables to bed [illegible] other roads or streets cross the line of mains, the latter are drawn through cast-iron pipes about 4¾in. diameter. To prevent any possibility of the mains being damaged by chance blows from pick or spade in case of future excavation along the route followed, terra-cotta tiles are placed above them, and a short distance above these, again, is buried a protective layer of narrow iron wire netting with large meshes.

Adjacent ends of the various lengths of mains are joined together in special junction-boxes made in two halves, and shown in Fig. 1, which gives two plans of such a box, one with the cover removed in order to expose the connections. Cross and longitudinal sections are also given. It will be seen from the illustrations that the two cable ends are bared, and the corresponding conductors firmly secured by brass jaws, fastened with screws. The cover is put into position after making the joint, then bolted down, and the box filled with melted pitch, or other insulating material, poured through three holes shown in the lid.

A similar type of box is used for connecting branches to the mains or feeders. It is, however, obviously of T form, as shown in Fig. 2, the three cables being jointed by brass pieces of special form, the whole box being then filled with insulating material, as already mentioned, in connection with the main junctions in order to keep moisture from entering the joints.

When circumstances or special conditions render it advisable to break the circuit anywhere in either of the two conductors in a main or cable, what are known as "switch-boxes" are provided—a vertical section and plan of which may be seen in Fig. 3. The ends of the two pairs of conductcrs—positive and negative—are secured by means of clamps, S_1S_1, to brass uprights, C C: the latter are screwed into bosses cast in the bottom of the box, and serve to support spring clips, G G. The box is filled with insulating material up to the level of the clips. If the object of this arrangement is only to break the circuit at any desired time in one part of the network, a simple copper connecting plug is used to join the conductor ends by being pressed down between the proper clips, being simply taken out when the circuit is to be broken.

In cases where it is desirable to protect a branch main of small cross-section when joined on to a feeder, a lead-wire fuse of the type shown in Fig. 4 is employed in a similar way, making contact between the proper spring clips. The copper plugs and lead fuses are cased with ebonite, with metal pieces slipped over the ends to ensure good contact. They are each grasped at the centre by a handle formed of wood dipped into a hot solution of bitumen or paraffin to insulate it, but as a further precaution the workmen are enjoined always to use indiarubber gloves when making or breaking the circuits. The switch-boxes are each covered with a cast-iron lid, the joint being made with an indiarubber ring. To further guard against the retention of moisture, a small receptacle containing chloride of calcium is placed inside the box, and the latter itself is fixed in a brickwork chamber closed on the ground level with a cast-iron lid.

The distributing cable at a consumer's house is led into a cast-iron box where the copper strands are held by clamps. A cover of wood soaked in an insulating material is provided for the box; and through it are brought the primaries from the transformer.

Some interesting details concerning the mode of manufacture of the concentric cables thus employed in a very important section of the Paris electric lighting scheme may not be out of place in this connection; and we therefore append a few particulars of the processes involved, as they are to be seen in the workshops of the Société Cail.

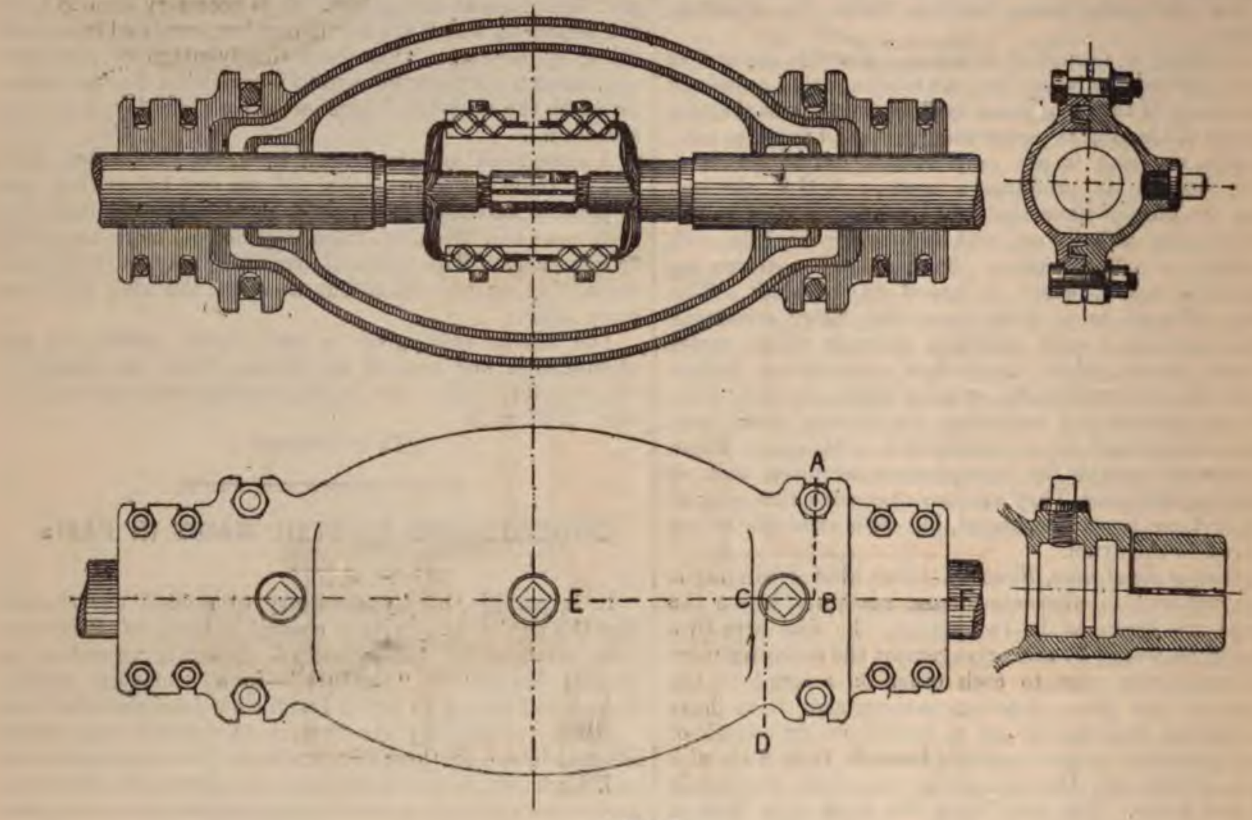

Fig. 1.

The central strands of copper are of course formed in the usual way by means of a rotating disc, with bobbins of copper wire arranged on its periphery. Two layers of tape are served upon the core thus formed, being wound in opposite directions by similar machines. The cable is then passed through the hot bath of insulating material, this process taking place in boilers under atmospheric pressure simply; the first serving of lead then follows under a pressure of 50 or 60 atmospheres. After this, a layer of bitumen is put on, then a second coating of lead, followed by a layer of jute; the armour, in the shape of a double wrapping of steel ribbon, and, finally, two layers of strong tape served with bitumen.

Fig. 5 shows a cross-section of a cable made in this fashion, of a diameter equal to about 3in. As shown in the illustration, the inner layer of insulating material has a thickness of 8mm., following which there comes the layer of lead, 1·8mm. thick; then a second layer of insulation, 6mm., and two layers of lead, 4·8mm. and 3·4mm. thick respectively. Last of all comes the iron armour, of a thickness equal to ·8mm.

The total insulation resistance is stated to average 4,000 to 5,000 megohms per kilometre; and as to the various parts, it appears to range from 2,600 megohms per kilometre between the outer conductor and earth, to 8,500 between the inner conductor and earth; the average being kept up between the two conductors. The cables are tested to a pressure of 6,000 volts between the two conductors, the normal or working tension being half this amount.

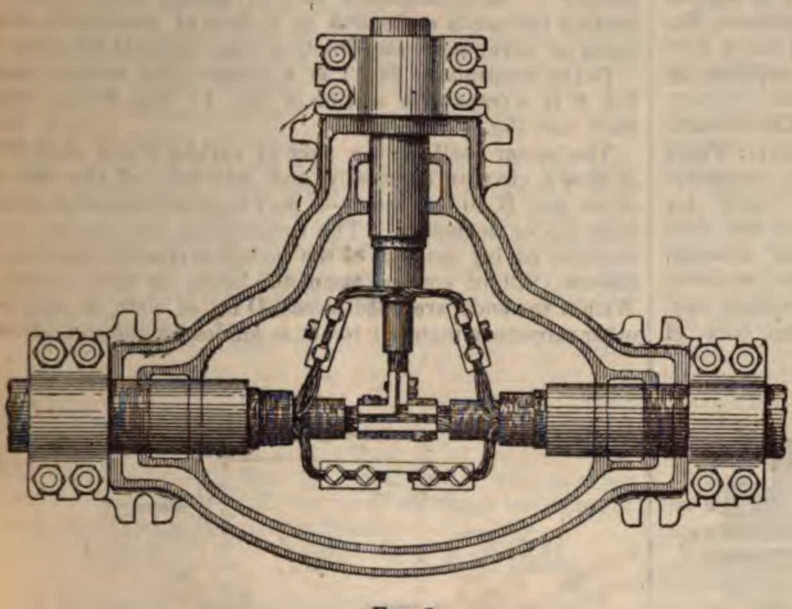

FIG. 2.

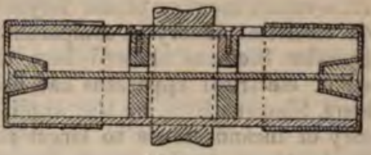

FIG. 4.

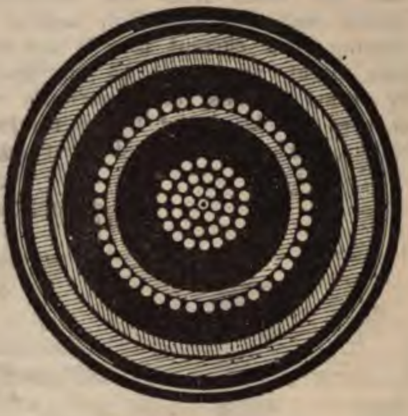

FIG. 5.

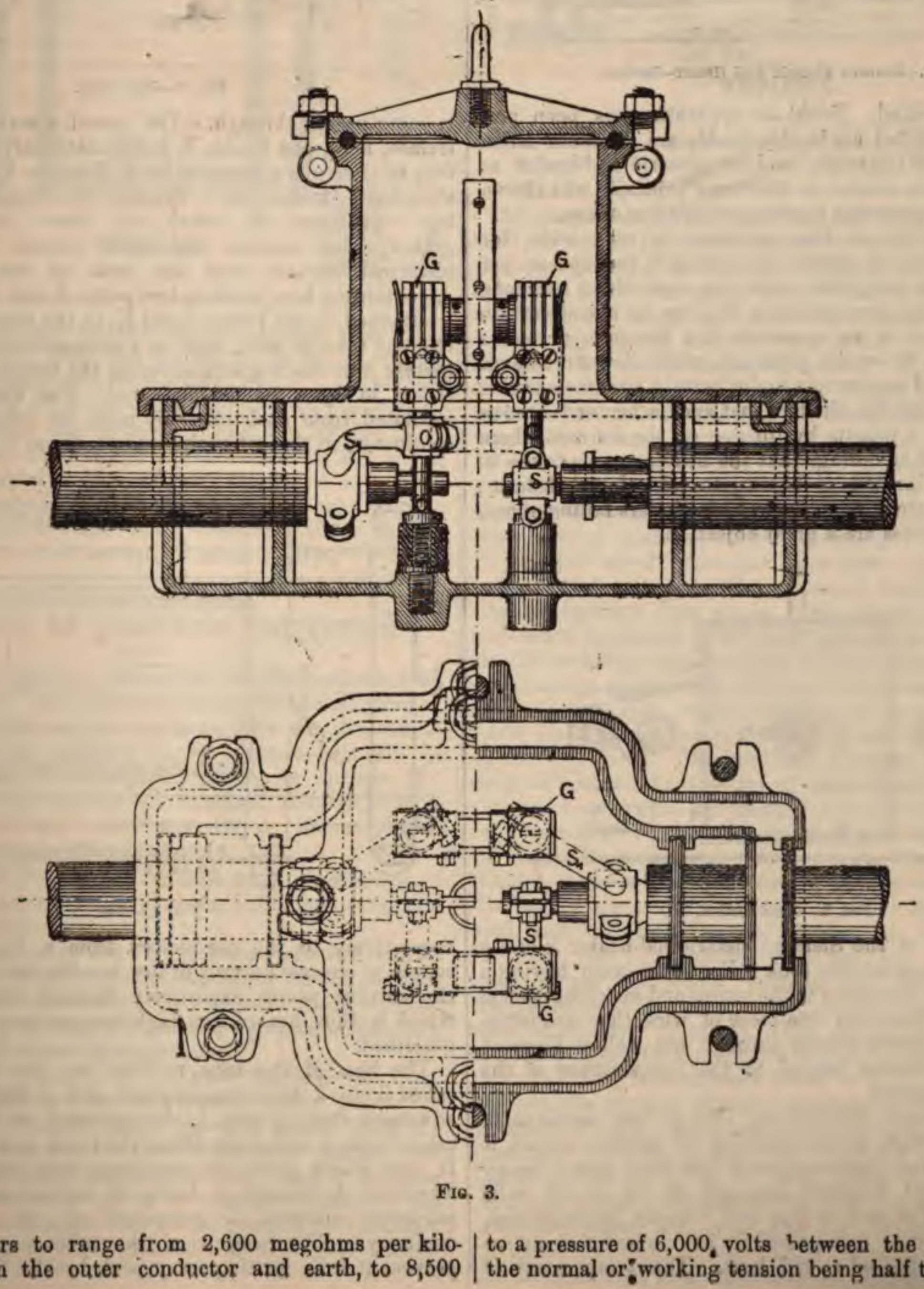

FIG. 3.

ELECTRIC ROD AND RIVET HEATERS.

At a recent meeting of the Royal Institution, in dealing with electrical theory as compared with the practice, Mr. Alexander Siemens showed how the demand for a new piece of electrical apparatus had been at once supplied by Messrs. Siemens Bros. by the application of the ordinary theory of incandescence to larger purposes. The demand arose in the first place from Sweden, we believe, where nails are made from soft Swedish iron in quantity. Where water is plentiful, and a dynamo used for lighting, the current that is not required in the daytime might very well be employed, it was thought, by some means to electrically heat the nailrods or bars and blanks of iron in making nails, screws, key-blanks, springs, files, and other articles where bars of iron are first heated. Such an apparatus has been perfected and patented conjointly by Messrs. Siemens Bros. and Mr. A. D. Williamson, and an electric rod-heater as well as an electric riveter on the same principle was shown in action at the scientific meeting referred to above.

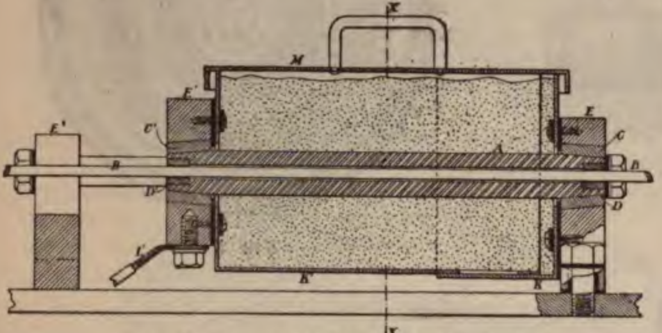

FIG. 1.—Siemens Electric Rod Heater—Section.

The applicability of the invention is very wide, for although the cost of current in heating is perhaps as yet against its use as compared with the cost of an ordinary forge, yet in many circumstances it is by no means certain whether the cost is so excessive if a dynamo, or mains bearing current, be on the premises, while its convenience for engineers and contractors under certain circumstances is beyond praise. Besides the fact that such a heater is always ready for use in a minute by turning on the current, there is the very great advantage that the heater can be taken to the work itself, instead of having to take the work to it; and, further, there is no danger of hot cinders falling about, which in some cases are a great objection.

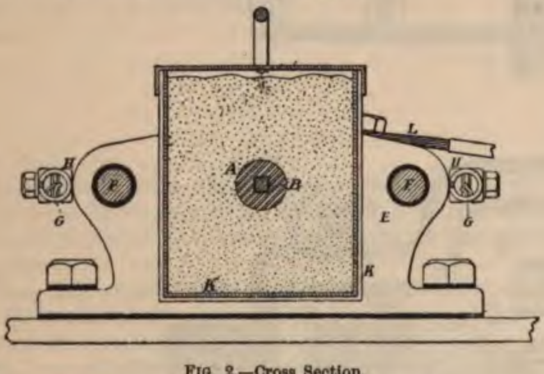

FIG. 2.—Cross Section.

The principle of the Siemens electric rod-heater is easily understood. Suppose one took a Bernstein lamp having a hollow filament; connect it to the source and make the carbon incandescent. Then any fine piece of wire that was introduced into and drawn slowly through the hollow filament would rapidly become heated to the temperature of the incandescent filament.

Instead of a mere filament and one or two amperes of current, take a huge hollow cylinder of carbon; attach it firmly between two large terminals, and then pass a heavy current of several hundred amperes at 10 or 15 volts through this. The carbon core will become incandescent, and any stout rod of iron passed in at one end and out at the other will be heated to red heat. The temperature of the rod can be regulated quite easily, either by altering the current passing in the carbon core, or more easily by simply passing the rod through more or less quickly. The incandescent core of carbon which acts as heating furnace is embedded in a bath of non-conducting material, silver sand, slag wool, or other suitable material.

In the illustrations Fig. 1 is a longitudinal section, and Fig. 2 is a transverse section of Fig. 1; Fig. 3 is an end view, and Fig. 4 the plan.

The heater itself, A, is a tube of carbon which may be, as shown, circular externally, and internally of the shape of the rod, B, to be heated—it may be either in one piece or built up of segments. The connections for current are made by coning the ends of the carbon to receive two coned sleeves, C C¹, of copper, gunmetal, brass, or other metal. Within the ends are fixed pieces, D D_1, of slate, kaolin, or other refractory material, to act as guides for the rod which is being passed through. The coned sleeves are fitted in frames, E E_1, one frame, E, being stationary and the other free to slide along guide-bolts, F, fixed to E, and to a third stationary frame, E_2. Springs, G, attached to porcelain insulators, H, serve to draw the frames together, thus causing the coned sleeves to make good electrical contact with the ends of the carbon tube. A containing box, made in two parts, K and K_1 (of which K is attached to the frame E and K_1 to the frame E_1), contains the slag wool or sand, used as a non-conductor of heat, completely surrounding and covering the carbon tube, A—it is closed in by a removable cover. The various parts are insulated from each other by mica or other suitable non-conductor, so that when the frames, E and E_1, are connected respectively to the conductors from a dynamo, or other source of electric current of low tension but large quantity, the current passes exclusively through the carbon core, which is thus heated to a high temperature in the manner described.

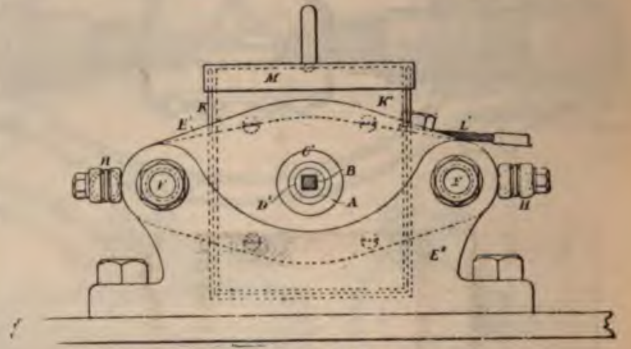

FIG. 3.—End View.

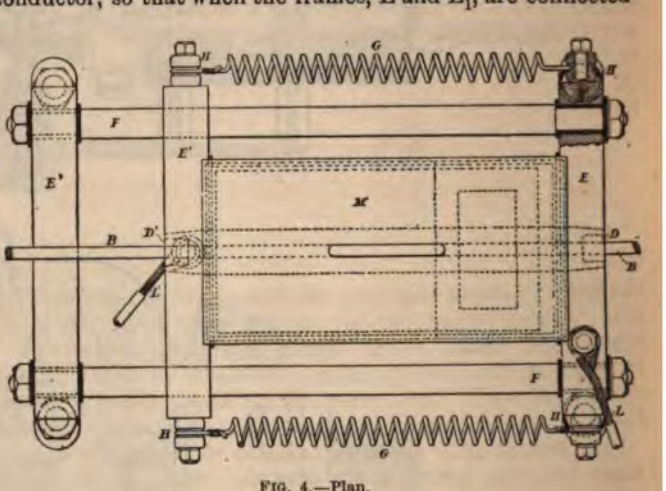

FIG. 4.—Plan.

The heat of the tube radiated on the rod or wire, B, raises it to a high temperature, and as this rod or wire is advanced step by step to be operated on by hammers or other tools, it issues hot from the front end of the tube at D, near which point the operating tools may be arranged. The tube, A, instead of being of carbon may be of other refractory material or compound of low electrical conductivity. The interior of the tube may be glazed to prevent it from wasting away, and, besides the bed of sand or the like which it occupies within the box, it may be sheathed with asbestos, slag wool, or such like material.

Instead of the springs, G, wire cords passing over pulleys and attached to weights are sometimes used; and instead of fitting the coned ends of the tube with coned sleeves pressed on them as described, these ends might be held in conducting clamps of other kinds, such as are used, for example, in holding pieces of metal when they are being electrically welded together.

The inventors also say that the interior of the tube might, by means of a pipe leading into it laterally, be kept supplied with hydrocarbon vapour, nitrogen, or other gas of neutral character, so as to avoid injurious oxidation of the metal rod or wire passing through the tube. In the specimens we have seen, no such complication as this was thought necessary.

The current was simply turned on, regulated by means of suitable resistances, and the heater was in a very few minutes at sufficient temperature. The rod was then passed slowly through, and if for making a spring is wound on a mandrel as it issues from the core; or if for making nails, files, etc., is operated upon by the workman who manipulates it as it issues from the core, the exact temperature being regulated with sufficient nicety.

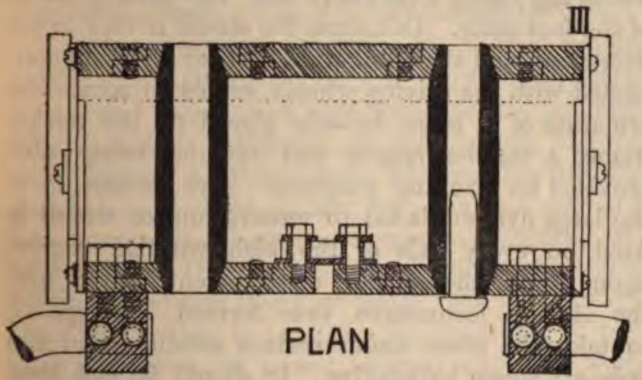

Fig. 5.—Electric Rivet Heater.

A somewhat similar electric heater has also been made by Messrs. Siemens Bros., and was shown by Mr. Alexander Siemens in the shape of a rivet-heater, Fig. 5. In this case small openings are made into which the rivets are placed, their heads resting upon the outside. These are left for a few moments, and are then picked up as wanted by the boy in attendance, dropped into place, and hammered into shape in the usual way. Engineers and contractors who have to do their work quickly and neatly may find these electric furnaces, rod and rivet heaters, of great utility.

MR. PREECE ON LIGHTNING PROTECTION.

The following letter to the editor of *Nature* from Prof. Oliver Lodge has been forwarded to us by the courtesy of the editor at Prof. Lodge's request. We are pleased to give the letter the publicity of our columns. It will be remembered that Dr. Lodge's position, as against Mr. Preece's, was reaffirmed by Mr. Shelford Bidwell, F.R.S., at his recent lecture before the Royal Meteorological Society. Dr. Lodge writes:

"In the recent presidential address to the Institution of Electrical Engineers by Mr. Preece, I find the following reference to myself:

"'Prof. Oliver Lodge has . . . . endeavoured to modify our views as to the behaviour of lightning discharges, and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience.'

"I was quite prepared to laugh at this with the rest, but I find that the general and semi-scientific public are apt to take Mr. Preece's little jokes, of which there are many towards the end of this address, as serious and authoritative statements of scientific fact. And it has been represented to me that unless I take some notice of the above, it may be assumed that I wish silently to withdraw from an untenable position without acknowledging having made a mistake.

"Indeed, I have already been questioned by a scientific worker as to whether I accepted the above statement as in any sense corresponding to truth.

"My reply is, that so far was I from that attitude, that I did not suppose that the statement was either meant or would be taken seriously.

"The broad question of scientific fact is this: Given an electrostatic charge at high potential, can the potential be reduced to zero most quietly and safely by a good conductor or by a bad one?

"The old lightning-rod doctrine (or drain-pipe theory) said: by an extravagantly good one. I say: by a reasonably bad one. If you employ too good a conductor the mean square of current is appallingly strong, and all manner of dangerous oscillations are set up; whereas in a bad conductor the discharge can be more nearly dead-beat. These oscillations have been experimentally and mathematically demonstrated in a great variety of ways, the unexpected and distinct effects they are able to produce have been displayed, and Messrs. Whittaker have published for me a large book about them.

"Some critics have sensibly objected that the book is too big, but I am not aware of any scientific authority who controverts my position.

"If Mr. Preece only means that these views regarding lightning and its dangers are not yet practically accepted by the great British Telegraphic Department, that is, I admit, perfectly true. "OLIVER LODGE."

REVIEWS.

Electrical Tables and Memoranda. By SILVANUS P. THOMPSON, D.Sc., B.A., F.R.S., and EUSTACE THOMAS. E. and F. N. Spon and Co., 125, Strand, London.

An electrical pocket-book has two desiderata—that it shall be small and shall contain everything of use to the electrical engineer in the way of figures and formulæ which he cannot remember in his head, but is constantly needing away from his larger books. Tested on these grounds, there is certainly a great deal to be said for Prof. Thompson's and Mr. Thomas's little pocket-book of "Electrical Tables and Memoranda," just issued by Messrs. Spon and Co., price 1s. 1d., post free. It is so small that except for its bright red colour it could hardly be seen—it is exactly 2½in. by 1¾in., gilt edged, with numerous illustrations, contains 120 thin pages, and references to over 200 distinct subjects, and it goes with the greatest ease into the waistcoat pocket. There is actually room besides for 20 pages of advertisements! For such a tiny morsel of a book a great deal of care and accuracy has been expended. Electric lighting data comes first—horse-power, amperes, and watts consumed. Different systems are discussed succinctly, and diagrams are given of three-wire system and the arrangement of domestic lighting with accumulators. Size of conductors, area, weight, and current carried at 60deg. at 1,000 amperes per square inch, are given from No. 20 wire up to $^{37}/_{12}$ cable. We find the formulæ for calculating drop of potential: this is, of course, very good. We also find instructions for jointing cables, which is, perhaps, not so good; for if a man cannot joint a cable before, buying an electrical pocket-book will not make him able to do it. Besides, this is not what he wants in a pocket-book. He wants directions, tables, formulæ that are to be used, and which he cannot remember without books. However, Dr. Thompson does not sin much in this way, though we would wish to find Hopkinson's and Kapp's formulæ—those used in actual work. The fuse table is full and practical. The magnetisation curves of iron from Hopkinson are given for annealed wrought and grey cast iron; formulæ and tables of the pull of electromagnets, the winding of electromagnets to get such or such an effect. All this is excellent—a whole work on magnetism condensed to a few pages. Dr. Lodge's conclusions on lightning-rods are given in brief; units of length, area, mass, and volume (French and English), of force, pressure, work, and power are noted, and then this very admirable and useful electrical engineer's little pocket-book concludes by a table of logarithms from 0 to 99, and a copious index.

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TO CORRESPONDENTS.

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THE HEILMANN ELECTRIC LOCOMOTIVE.

A considerable amount of adverse criticism has been openly—as well as privately—bestowed upon the remarkable scheme brought forward some little time ago by Mons. J. J. Heilmann, of Paris, in connection with the development of electric railway work; and these criticisms are deserved or not according to the objects with which the designer may be credited.

Most of the details of this project will be familiar to our readers, but to briefly restate them, it may be said that the idea is to furnish a complete self-contained electric-power installation upon a vehicle somewhat resembling an ordinary locomotive. That is, the steam-boiler of locomotive form is retained, but instead of putting the steam-cylinders beneath the forward end of the smoke-box, etc., the engine itself, with valves and other motions, is of the compound type, and placed transversely across the frame somewhere near the usual position of the foot-plate. Of course the stroke is very much shortened, and the crank-axle, instead of being connected with the driving wheels, serves to rotate the armature of a large dynamo placed on the tender frame, a smaller engine and dynamo being also provided for exciting purposes. The current from the large dynamo is led to motors, one of which is fixed on every axle of the eight-wheeled bogies, upon which the whole arrangement runs; and the electric locomotive thus formed is supposed to take the place under certain conditions of the ordinary steam locomotive. It should be said that side tanks are employed to carry a supply of water for the boiler, and some space is also provided for coal.

We have said that the adverse criticisms already showered upon this highly original project are fully or not at all merited, according as the motives which underlie the project receive due credence or not. It does not require any great amount of engineering knowledge or experience to say at once that for practical everyday working the adoption of such a method is not to be dreamt of for a moment. However much may be said in favour of the saving in fuel, etc., from the employment of a compound engine, operating highly efficient dynamo and motors, and the great advantage of the whole appliance being self-contained, and independent of a generating station where breakdowns are conceivable, yet such good points must inevitably be overbalanced by the extra dead-weight to be carried alone, if for no other reason, as compared with the results that ought to be obtained on a system where a supply of electric energy is given from a central station.

But, unfortunately, the conditions ruling such a supply for high-speed traction are to-day by no means so perfectly understood or managed as might be wished; and, besides this, the outlay necessary for any serious test of electric railway work is so heavy as to practically forbid the least attempt in this direction until our knowledge, at any rate, is more complete. This state of affairs may be likened to the condition of the "skolastikos" of our school-days, who, after nearly getting drowned, vowed he would never go into the water again until he could swim.

M. Heilmann is therefore not by any means to be laughed out of court as an impracticable visionary; so far from that, his project—carried out as it will be under the auspices of the French State railway engineers, with appliances made by such firms as Brown and Boveri, the Forges et Chantiers de la Mediterranée, etc.—ought to prove of material benefit not only to railway men in general, but more especially to those who are interested in the progress of electric traction at high speeds. It is doubtful, however, unless very special preparations are made, whether the Heilmann locomotive could run at, say, 100 or 120 miles an hour on any ordinary railway line, even assuming as actual facts the mechanical qualities claimed. Not only is there a limit to signalling capacity if a strict block system be observed, but other traffic must be considered, whilst the question of suitability of the permanent way for so severe a trial is a very serious matter.

Yet it is just such performances that we require now, and the engineer who will carry out any trials on a sound basis which may elucidate the mysteries of train and air resistance at high speeds, together with numerous other points affecting the development of more rapid transit, will confer a very solid benefit upon the electric and railway interests. We hope that M. Heilmann—when his locomotive shall be completed and ready for work—will make careful tests with a view to ascertain the resistance to traction, etc., and the power actually expended when running at higher speeds than any now usual. It should be quite possible for such an appliance as that he has devised, under the proposed conditions, to prove a most useful source of information and experience, apart altogether from the question of its suitability or otherwise for regular everyday work.

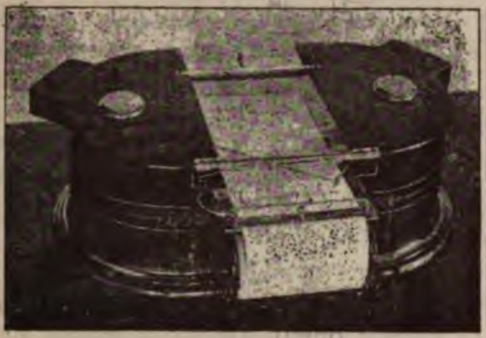
LARGE AND SMALL.

The man that is capable of doing a small thing well is the one that is capable of doing a large thing well—"He that is faithful in little is faithful also in much"—and the large things pay much better for the same amount of time and thought given to them. The habit of dealing with affairs—engineering and commercial—is largely a question of imagination rightly directed, the faculty of looking ahead and of "thinking in the solid." One of Edison's peculiarities is the immediate power of thinking in the solid, and of realising the exact bearing of parts to whole, which is the direct gift of a powerful mind; and with every man of note the same power is at the bottom of their success. It is as easy to the mind of man to imagine large things as small, and, as we have said, it pays better to carry them out. The young electrical engineer, then, should habituate himself, while practising his hand on the small, to practise his mind on the large works of this life. The thorough experience of all and every kind of electrical machinery can to a very large extent be acquired with small resources, and the man who has fifty pounds on which to equip his private electrical laboratory might count himself rich in these days of transformation of power, and be able to have within his reach the manipulation of forces, with which, applied on a larger scale, he may hereafter cause revolutions in industry. A water-motor bought for a few pounds may serve as prime mover; even a gas-engine can be bought cheap in these days of second-hand machinery. A small dynamo can certainly now be picked up cheap enough—serviceable, if not of new type nor very clean. A secondary battery of fifteen cells to give five amperes will light five thirty-volt incandescent lamps, and consists mostly, be it remarked, of lead plates. Add a few large primaries (those you use for plating) on the circuit, and a Midget arc lamp will give 200 c.p.—a splendid light. If the dynamo has added to it by an extension of the commutator, collector rings, as well as commutator, the young experimentalist can obtain alternate currents—nay, with three rings, three-phase currents from the same dynamo; and if he is skilful enough to build a second dynamo on the model of the one he has bought, he may transmit power by continuous, synchronous, or three-phase motor by one and the same set of motor and dynamo. A transformer is not so very difficult to make; he can then, if he pleases, obtain his two thousand, perhaps ten thousand, volts—though here he should be careful. A Ruhmkorff coil and a few despised Leyden jars may introduce him to the mysteries of Teslaic currents and phosphorescent tubes.

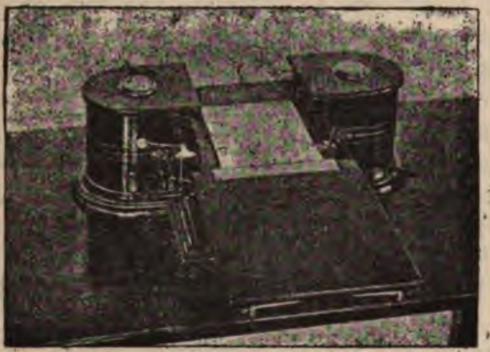
Having lived in an atmosphere of actuality, though on a small scale, of real electrical engineering, our supposititious experimentalist has learnt to adapt himself to problems of all kinds, is in touch and feeling with the mysterious force, from motor to lamp, and from ampere-turns to Hertzian undulations. Let there be added an equal actual acquaintance picked up at college, works, a neighbouring factory or station—where he can, the more thoroughly the better—of engines and engine-driving, boilers, and water-heaters, and let him learn how to calculate the loss of power and potential in copper mains, and his power of thinking solid may, with not too great difficulty, simply change its scale, so that units which were of the dimension of one or two—in horse-power, amperes, or pounds—may become units of thousands in work of larger scale. The proverbial foresight, persistence, enterprise of the Anglo-Saxon race may, too, become embodied in him; and from small beginnings it may be the proud lot of the young experimentalist to take a leading part in the great revolution which is now so rapidly coming upon us, of changing the steam-engine age into the electrical age, and so of aiding, to the utmost extent of his power, in the material and mental progress of the world. It has always and must always be so: the men who are now learning will soon be leading. Little by little the carrying on of the world's work falls to the men who were unregarded "young fellows." The world's history shows that its leaders now lead by reason of their mental power and foresight gained in practice on small things. In electrical engineering this is no exception, and the youth who is now tinkering at models, or wiping a dynamo commutator, or spending his evening hours in winding coils, may suddenly meet his opportunity and be called upon to do the larger work. He should be ready. He that is capable of doing a small thing absolutely well may be capable of doing large ones well, and the world has need of such men.

ELISHA GRAY'S TELAUTOGRAPH.

The telautograph, or telegraphic writing-machine, of Prof. Elisha Gray has now apparently been brought into a state of sufficient perfection to be put into practice. On March 21 the first public exhibition of the telautograph was made at Chicago and New York, where the machines were inspected by the representatives of the electrical and daily newspapers. At Chicago an exchange system had been fitted up, comprising a central exchange and several subscribers' offices. The central office contained a receiver and transmitter, and a switchboard resembling a small telephone exchange switchboard. Each subscriber had two machines, as shown in the illustrations—a receiver and a transmitter—placed on a table about 4ft. square. The machines are compact, and can be worked by any ordinary person after a little preliminary practice. These machines are the latest improved practical type. They are the outcome of many experiments variously constructed since the first in 1887.



Telautograph Receiver.



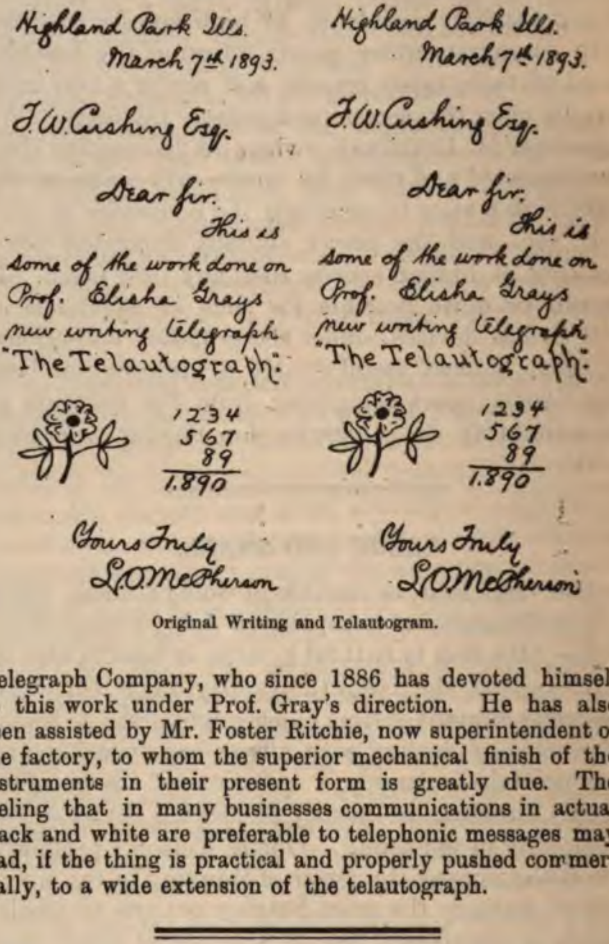
Telautograph Transmitter.

The transmitter and receiver are separate, and each is an instrument in itself, the transmitter being furnished with a board to facilitate writing. The receiver is very compact. The pen arms are covered with glass, and all working parts are under cover, so there is little liability of their being affected with dirt or touching. In sending a message an ordinary lead pencil is used, near the point of which two silk cords are fastened at right angles to each other. The cords connect to the instrument, and regulate the current, which actuates the pen at the distant receiver. The writing is very conveniently done, not on tape, but on ordinary paper 5in. wide, arranged on a roll attached to the machine. When the line is finished a lever is touched, which moves the paper forward mechanically at the transmitter and electrically at the receiver.

The receiver has a pen formed of a capillary glass tube placed at the junction of two aluminium arms. It is supplied with ink through a small indiarubber tube placed in one of the arms from a reservoir. The pen is moved electrically, exactly imitating the movement of the pencil, leaving a pen tracing, which is the fac-simile of the pencil writing of the sender. This is the case whether for letters, words, figures, signs, or even drawings, if done in lines.

A very good idea of the writing performed by the telautograph is shown in the photographic reproduction given of both writing and the telautograph fac-simile. A comparison shows the latter to be an exact fac-simile, and were it not that one is in pencil and the other in ink, they could hardly be told apart. The instrument's transmission of writing, sketches, shorthand notes, and figures is equally accurate, and its usefulness would seem great. A line has been established a distance of 23 miles, and messages were written at this distance without difficulty.

The telautograph will be exhibited at the World's Fair by the Gray National Telautograph Company. A factory has been established at Highland Park, Illinois, the residence of Prof. Gray, for the manufacture of these instruments. Prof. Gray has been assisted in his experiments with the telautograph by the chief of his electrical staff, Mr. L. O. M'Pherson, formerly electrician with the Postal Telegraph Company, who since 1886 has devoted himself to this work under Prof. Gray's direction. He has also been assisted by Mr. Foster Ritchie, now superintendent of the factory, to whom the superior mechanical finish of the instruments in their present form is greatly due. The feeling that in many businesses communications in actual black and white are preferable to telephonic messages may lead, if the thing is practical and properly pushed commercially, to a wide extension of the telautograph.



Highland Park Ills.
March 7th 1893.

J. W. Cushing Esq.

Dear Sir.
This is some of the work done on Prof. Elisha Grays new writing telegraph "The Telautograph."

1234
567
89
1.890

Yours Truly
L. O. McPherson

Highland Park Ills.
March 7th 1893.

J. W. Cushing Esq.

Dear Sir.
This is some of the work done on Prof. Elisha Grays new writing telegraph "The Telautograph."

1234
567
89
1.890

Yours Truly
L. O. McPherson

Original Writing and Telautogram.

Preserving Tools from Rust.—A good plan of preventing tools from rusting, says a useful note, is the simple preparation employed by Prof. Olmstead, of Yale College, for the preservation of scientific apparatus, and which he long ago published for the general good, declining to have it patented. It is made by the slow melting together of six or eight parts of lard to one of resin, stirring till cool. This remains semi-fluid, ready for use, the resin preventing rancidity and supplying an airtight film. Rubbed on a bright surface ever so thinly it protects and preserves the polish effectually, and it can be wiped off nearly clean, if ever desired, as from a knife blade; or it may be thinned with coal oil or benzene.

	TABLE I.—TEST FOR BREAKING STRAIN.											TABLE II.	
—	Size of sample—inches.				Breaking strain.		Extension.		Weight per foot in pounds.	Weight per foot ÷ breaking strain per square inch.	Breaking strain per inch width in pounds.	Friction.	
	Length.	Breadth.	Thickness.	Area.	Actual. Tons.	Per square inch. Tons.	Ultimate per cent.	Per 1cwt. per cent.*				Factor.	No. of experiments of which mean is taken.
Gandy cotton	18·5	2·04	·18	·367	1·6	4·35	9	3·1	·161	·037	1,740	·35	2
„ „ spliced	17	2·04	—	—	0·4	—	—	—	—	—	425	—	—
Hendry edge leather	18·375	1·96	·28	·549	1·0	1·82	3	0·78	·245	·134	1,140	·132	3
„ „ „ spliced	18·625	2·0	·27	·54	0·7	1·29	5	—	—	—	785	—	—
Gandy leather	18·375	2·0	·21	·42	0·85	2·04	4	3·15	·183	·09	940	·22	2
„ „ spliced	18·3	1·94	·18	·35	0·6	1·7	—	—	—	—	691	—	—
Dick's guttapercha, three-ply	18	1·96	·14	·274	1·1	4·0	6	0·78	·104	·026	1,250	—	—
„ „ „ four-ply	18·2	1·97	·17	·335	1·55	4·62	7·5	1·57	·126	·027	1,780	·168	1
Tullis link	18·25	2·0	·54	1·12	0·5	·45	4	—	1·14	2·52	560	·136	6
Hoyt's oak-tanned	18	1 95	·27	·526	1·2	2·28	8	—	·166	·077	1 344	—	—
„ „ with joint	18	2·0	·18	·36	0 95	2·65	4	2·35	—	—	1,050	—	—
„ „ split—grain portion	18	1·95	·12	·234	0·35	1·49	3	3·0	·083	·0555	850	·149	1
„ „ „ flesh portion	18	1·95	·12	·234	0·4	1·7	3	3·0	·083	·049		·166	1
Tullis orange tan	—	—	—	—	—	—	—	—	—	—	—	·151	5
MacLellan's rubber	18·25	2·12	·27	·572	1·1	1·92	2	—	·33	·172	1,140	·32	2

* The readings for extension with strain of 1cwt. are not accurate, as the testing-machine index is too difficult to read at so low a value for the strain.

BELTING FOR MACHINERY.*

BY HENRY A. MAVOR.

(Continued from page 337.)

Having then determined the tension in the driving and following sides of the belt we have to use this result in determining the size of band necessary to transmit the required power.

Table II. gives the results of tests on the breaking strain of belting. The samples were chosen from the classes of belting most used in this neighbourhood, and the results are very much better than those given in the records of older tests, showing a distinct improvement in the manufacture. The leather samples were all of single belting, and all the samples were approximately 2in. wide.

My experience in the use of belts is practically limited to leather, having found any attempt to use any other kind of belt uniformly unsatisfactory from various causes, chief among which are the troublesome liability to stretch, which is a property of belting made of textile material, and the liability to uncertain wear, which is found in belts which are not homogeneous in structure. The following remarks are therefore confined to the consideration of leather belts.

The strength of the belt is, of course, the strength of its weakest part, and this is generally the joint. We are safe to reckon that Nature and the tanner will make the body of the belt substance stronger than the most skilful and experienced jointer can make a joint in it. The breaking strain on a good joint in a single leather belt may be taken as the mean of the three results in Table II.—viz., 842lb. per inch width. Referring back to our example, it would appear that the maximum strain on a belt transmitting 10 h.p. under the conditions given would be 279lb., so that it would appear that if a single belt was worked up to the breaking point of its weakest part, it would transmit nearly 30 h.p. per inch width under the given conditions, and running 1,000 × π feet per minute. Here, however, come in very important limitations. The stretch in a belt under such a strain would be instantaneous and fatal to its stopping on the pulley at all. It is evident that the ultimate strength of the belt, taken by itself, is no guide to the power which may be transmitted by it. Under the title factor of safety, many figures, varying as much as usual, have been confidently stated as the proper ratio between the ultimate strength of the belt and its working strain $\frac{10}{1}$, $\frac{12}{1}$, $\frac{15}{1}$, $\frac{20}{1}$, etc. The fact, however, may be stated broadly, that the ultimate strength of the belt, while an important element in the question is so much less important than other elements that it may be left out of consideration in the assurance that there is no leather belt in the market which is not strong enough to stand any strain which can be put upon it in ordinary working conditions, this strain being limited by other conditions than the ultimate strength of the belt, to a point far below the breaking strain. Another element in the question may be dismissed here in a few words as being usually so small as to be negligible—viz. the increase in strain due to centrifugal force.

The weight of the belt itself (determined again by considerations entirely overshadowing the question of centrifugal force) is so small in relation to the pull which it has to transmit, that we only mention the method by which the curious in these matters calculate this quantity. The method will be found in Rankine's "Machinery and Millwork," page 441, and is:

$$\text{“}\frac{w\,S\,v^2}{g},$$

in which w is the heaviness (being for leather belts nearly equal to that of water); S, the sectional area; v, the velocity; and g, gravity = 32·2ft. per second."

The really important elements in determining what power a given belt will transmit are not expressible in figures, and can only be determined by trial of the belt in the conditions under which it is to work. If, however, we determine these for a belt made by a manufacturer of good standing, in whom we may place implicit confidence, we may safely base our calculations on experience with one or two samples of any width. Further, a knowledge of what these important elements are will enable us to select these samples with some prospect of satisfactory results.

The selection of hides and of portions of hides for belting is a business to which greater attention was paid for many years in America than in this country, but that pre-eminence is less marked now than it was 10 years ago. Further, various mechanical and structural devices have been resorted to to attain the desired results with materials which cost less than the particular kind of leather required to make first-class belting by the original simple methods.

The first essential in a belt which is to transmit power is that it shall keep on the pulleys. That it may do so, it must be straight to begin with, it must keep straight, and it must run straight. (2) It must have little longitudinal stretch, so that it will "keep up to its work." (3) It must be flexible, so that it will bend sweetly and easily over the pulleys with little loss of power, and that it will lie closely to the surfaces of the pulleys and offer resistance to relative motion of the surfaces. (4) It must be uniform in thickness, so that it will not vary in its properties of flexibility throughout its length, and thus produce irregularity of motion.

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* Paper read before the Institution of Engineers and Shipbuilders in Scotland.

(5) It must be thin, so as to absorb little power in bending it over the pulleys, and have small relative motion between its outer and inner surfaces, as such motion not only absorbs power by internal friction, and causes "creepage" (the caterpillar-like motion caused by the elasticity of the leather as the tension changes from the driving to the driven side), and consequent loss of power, but rapidly destroys the fibre of the belt. (6) It should be homogeneous in its structure, so that the strains may be equally distributed throughout its substance in all three directions. It should therefore be single wherever possible. (7) Which is really included in sixth; all stitching, lacing, or riveting in a leather belt is a source of weakness, reducing its ultimate strength by the holes. Therefore all joints should be cemented only. A good cement joint is stronger than any other, and disturbs the natural structure of the belt less than any other. All clamps, fasteners, etc., are bad. The best fastening for a belt when the proper working tension has not been determined, and a temporary fastening is required, is the laced butt joint, which should be removed and replaced by a cemented lapped joint as soon as possible.

It will be difficult, of course, to apply all these requirements to each individual case, but all are of great importance, and the efficiency of a drive will depend on how far they have been adhered to in their entirety. It is better to sacrifice initial strength of the belt than any of these other qualities, and the first two of these qualities are not to be sacrificed for any of the others, which are placed as nearly as possible in the order of their importance. A consideration of these requirements will show why plain single leather belting has held its own for the great majority of cases of belt transmission. Its weak point is that it is easily altered in its most essential properties by damp and heat, so that other materials have to take its place where the belts have to be subjected to such conditions. The same general requirements, however, remain to guide us in our selection. The most experienced makers of leather belting have fully grasped those requirements, and select those portions of the hide which most fully meet the first three of them. Those portions are not the strongest or toughest or softest portions.

(To be concluded.)

NOTES ON THE INFLUENCE OF ELECTRICITY IN TANNING OPERATIONS.*

BY CONRAD K. FALKENSTEIN, ASSOCIATE.

It has been known for the last 30 years that the application of an electric current to hides in process of tanning exerts a beneficial effect, increasing the rapidity with which the gelatinous material of the pelt combines with the tannin in the liquors to form leather. Before going further, it may be well to briefly sketch out what occurs when hides are tanned. Oxhide consists, roughly, of three layers, as follows: (*a*). The *epidermis*, consisting of an outer layer, which is constantly being shed, and an inner layer, from which the material of the outer layer is supplied. (*b*) The *pars papillaris*, of close fibre, in and below which are situated the hair sheaths, fat and sweat glands, and the muscles which erect the hair; the upper coat of this layer forms the "grain" of leather. (*c*) The *pars reticularis*, or corium, a network of fibres, which forms the greater part of the section; this is densest near the layer (*b*), the bundles of fibre becoming more open towards the flesh side. When the hide is taken off the animal the exterior of this layer is covered with flesh, fat, and tissue.

The first thing to be done is to wash the hide free from all blood, salt, etc., or, if sun dried or cured, to thoroughly wash and soften it (this is sometimes assisted by mechanical means); when clean and soft it is treated with solutions of lime of gradually increasing strength, which have the effect of swelling up the hide and splitting up or commencing to dissolve the fibres. This action takes place most vigorously at the two surfaces; on the grain side it dissolves away the outer cells or epidermis, and the hair *papilla* or knob of corium, which holds and supplies nourishment to the hair, thus allowing it to be easily scraped off by the blunt unhairing-knife; on the flesh side it plumps up the *pars reticularis*, causing it to be easily distinguished (by its firmness) by the flesher from the loose membrane and fatty matter which is to be removed. When the hair and flesh are removed, the hides are washed and worked over on the grain side with a stone or blunt knife to force out the lime solution and the remains of hair, epidermis, etc., which are left in the hair cavities after unhairing; after another washing, the hides are ready for tanning. Now the hide material or gelatine to be tanned consists of bundles of fibre, each bundle being made up of a refractory base, surrounded by gelatinous, tannable fibres, the axes of which lie generally at right angles to the surfaces of the hide. After liming, the fibres are in a swelled condition, both acids and alkalis (with exceptions) having this property of distending the hide, and causing it to absorb water. The action of the tannic acid is to displace the water, and while converting the gelatinous fibres into leather, to maintain the plumpness by an acid reaction after the lime has been neutralised. Other methods are employed for unhairing on the Continent and elsewhere, such as sweating or partial putrefaction, use of sodium sulphide, etc., in which this plumpness has to be produced by the use of sulphuric, acetic, or other acids, or by liquors which contain acetic, lactic acids, etc., through natural fermentation. The hides are then treated with solutions of tannic acid of gradually-increasing strength, until they show a uniform brown colour in a freshly-cut section (lighter or darker according to the tanning materials employed), and have the necessary firmness and weight. Care must be taken as to the rate at which the tannic acid solution is increased in strength, for if, after the tannage is fairly commenced and the lime neutralised, the hides be not fed with stronger and stronger liquors, they lose their firmness, and are said to "go back," after which a species of putrefaction is set up in the interior untanned portion of the hide which causes adjacent bundles of fibre to unite, thus destroying the open fibrous structure of the hide, and practically stopping diffusion; this result may also be produced by using too strong liquors at first, which bind up the pores and prevent liquor from reaching to the interior. For dressing leather somewhat different methods are followed, but the same precautions must be taken in working the liquors as just described. The above is the process to be gone through, the functions of the electric current being: 1. To increase the rate at which liquor diffuses itself through the hide, by endosmose effects. 2. To increase the chemical activity of the reaction by molecular vibration.

Many methods of applying the current have been proposed, some depending upon the action of the gases evolved at the electrodes, and others upon the endosmose and molecular effects of the current on the hides and liquor. M. Gaulard patented a process in 1883, making use of the first method, the hides being suspended in a pit, from the perforated false bottom of which is sent, first, a stream of hydrogen from the cathode; after eight days the current is reversed, and the hides subjected to the action of a stream of oxygen until they were tanned. The other method, which has been employed by Gaulard, Landin and Abom, De Meritens, and others, is to use a pit with electrodes on opposite sides, and pass the current through the liquor and suspended hides at right angles to their surfaces. When the hides are struck through they are transferred to the layer pits, where they are put in alternate layers with ground bark, etc., liquor being run in either before or afterwards. The current is now applied by electrodes, placed one underneath and one on top of the pile, the positive pole generally at the bottom. This laying away is repeated until the hides are tanned. By thus applying electricity to the ordinary methods of the tannery, the time necessary for tanning heavy sole leather may be reduced from 120 to 45 days, as proved by the practice of Messrs. Landin and Abom in Sweden, and De Meritens at St. Petersburg. Messrs. Landin and Abom use alternating currents. If now the electrical action be assisted by suitable mechanical agitation of the liquor and movement of the hides, so as to mix the liquor which has passed through the hide with that remaining in the vat, we shall obviously have an increase in the rate at which the tannage proceeds.

Several processes have been devised to combine the effects of the electric current and motion, amongst which may be mentioned those of Messrs. Worms and Balé, L. Groth, and others. Mr. Groth's process employs a vat, in the centre of which is a rotating or reciprocating (according to the shape of the vat) frame, on which are suspended the hides or skins to be tanned, an electric current being passed from one side of the pit to the other, through the liquor and hides. This process reduces the time necessary to tan a hide to about 28 days. Messrs. Worms and Balé's system combines the application of an electric current with the use of a rotating drum; the drum is about 11ft. in diameter, and provided with internally projecting pegs; in operation it is nearly half filled with liquor, and the hides being put in (one by one), the drum is closed and rotated; while in motion an electric current is applied by electrodes, so disposed as to fill the liquor with, and hence subject the hides to, a uniform field of endosmotic force. When the drum is in motion, the hides, floating in the body of the liquor, are turned over, and the liquor mixed, the bottom layers being continually brought to the top by the skin friction. Under these conditions, running continuously, hides may be tanned in about 100 hours. It will be seen that the rotating drum contains four variable factors: 1. The strength and disposition of the electric current. 2. The speed of rotation. 3. The proportional amount of liquor in the drum. 4. The length and number of the projecting pegs. Thus giving the system considerable flexibility of treatment. It has now been worked on a commercial scale for some years by the British Tanning Company, Limited, in London, by MM. Brion et Dupré in Paris, and also in America. Considering the purely electrical and chemical effects on the hides and liquor, it has been established by the experiments of Messrs. Rideal and Trotter, Prof. Müntz, of Paris, Dr. Foelsing, Dr. Zerener, and others, that the final result—viz., raw hide—is capable of combining with its equivalent weight of tannic acid in from 4 per cent. to 38 per cent. of the time taken when electricity and apparatus or electricity alone is not applied according to the process employed.

Below I give particulars of some experiments which I have made, bearing on the action of the electric current. Let us first consider what happens when a current is passed through a carefully filtered solution of tannic acid, made from an oakwood extract, using platinum electrodes. The cell employed was divided into three by two porous clay diaphragms, each compartment being of equal capacity, 200 c.c., and containing 150 c.c. In the first compartment was placed the anode, and in the third the cathode, the intermediate one completing the circuit. A current of 0·0024 ampere was applied at a P. D. of seven volts. On completing the circuit the following actions took place : at the anode bubbles appeared and collected round the wire as a straw-coloured froth ; at the cathode there was considerably more evolution of gas, and the froth produced was darker in colour and showed streaks of dark-red colouration radiating from the wire. After passing the current for 90 hours it was stopped, and the electrodes and liquor examined. The anode had a small quantity of soft brown precipitate on its surface ($\frac{7}{8}$in. × $\frac{7}{8}$in.) which was easily soluble in warm distilled water, and was absorbed by hide powder ; the cathode was covered closely with a hard dark-brown coat of precipitate to the depth of from $\frac{1}{64}$in. to $\frac{1}{32}$in. at the edges. This precipitate is insoluble in hot distilled water, but is immediately dissolved on addition of a very small quantity of H_2SO_4, forming a clear tan-coloured solution which is bleached on treatment with hide powder, thus proving the precipitate to be a dark tanning colouring matter. On examination the liquid in the three compartments, No. 1, containing the anode, was as clear as at the commencement of the experiment, so was No. 2, both having a slight coat of tannin anhydride on the bottom ; No. 3, containing the cathode, was somewhat turbid with dark-brown particles which were soluble in hot distilled water and absorbed by hide powder. At the end of the experiment it was found that in the compartments 1 and 2 the level of the liquid had fallen and in 3 it had risen.

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* Paper read before the Institution of Electrical Engineers.

The above gives a general view of the action, which I have amplified as follows : I. To compare the endosmose effects in solutions of tannic acid, at varying potential differences, at varying strengths of tannic acid, and with diaphragms of different materials. II. To compare the precipitation of anhydride, etc , in solutions of tannic acid, when a current of electricity is passed through them, and when allowed to remain during the same time and under the same conditions, but without passing a current. III. To examine the amount of tannin in the liquor before and after passing an electric current.

I.—Endosmose.

Cells were made consisting of two ebonite boxes (each having one side cut away), fastened together with a plate of porous clay or leather between them, thus forming two compartments, joined through a porous diaphragm, each having a capacity of 200 c.c. In experimenting, 100 c.c. of the liquor to be examined was placed in each compartment, and the current applied from accumulators, etc., through platinum electrodes, and the variation of level with time noted ; the top and bottom surfaces of the cells were made parallel and carefully levelled during experiments Between each set of readings the clay diaphragm was cleaned and allowed to soak in water, so that the mechanical resistance to flow of liquor might remain as nearly constant as possible. This method was adopted as the apparatus is simple, and if differences of level between the two sides of the diaphragm be considered evaporation errors are eliminated, as the surfaces exposed to the air are equal in both compartments. The first experiments undertaken were to see in what way the rate of flow varied with the difference of potentials applied, the results of which are shown in the following tables (curves were also shown) :

Table A_1 and A_2.

I. Volts.	II. (Volts)^2.	III. Tangent to curve.	IV. Mean current by voltameter.	V. Proportional rate of flow.	VI. Calculated rate of flow.	VII. Proportional current.
4·7	22·09	0·27	0·00089 A	0·22	0·2	0·13
9·0	81·00	1·22	0·0066 ,,	1·00	1·00	1·00
13·2	174·24	2·71	0·0162 ,,	2·22	2·15	2·45
17·7	313·29	4·42	0·0274 ,,	3·62	3·86	4·15

From A it may be seen that : (1) with an approximately constant mechanical and electrical (at one voltage) resistance, the rate of flow of the liquor varies at a higher rate than simple proportionality to the voltage between electrodes (see columns I. and V.) ; (2) the current varies at a slightly higher rate than the rate of flow, as measured by tangent to curve (see columns V. and VII. ; see also curve A_2) ; (3) the rate of flow approximately varies as the square of the voltage (see columns V. and VI.).

In order that Ohm's law may be satisfied, it follows that the resistance of the tan liquor examined must vary inversely as the potential difference applied. In some experiments I am making on this point, I find that between certain limits of current density the resistance varies inversely as the E.M.F., but after the solution has been subjected to electrolysis for some time at the higher current density it loses its power of offering an increased resistance to a lower potential difference, the resistance remaining fairly constant at the minimum value for all potential differences below the high one which broke it down. This, taken in conjunction with the results given in Division III., points to an alteration in the structure of the tannin molecule being produced by electrolysis, the resinous dark tanning matter being separated in the form of unsoluble precipitate on and about the cathode, the remaining liquor being of higher electrical conductivity and clearer, the amount of available tannin remaining constant, although in separate forms. The next experiments were made to find in what way the rate of flow varied with the percentage of tannin in the solution, at constant potential difference, and using the same porous diaphragm in each case.

Table B.

Percentage of tanning.	Volts.	Mean current.	Rate of flow.	Proportional rate of flow.	Proportional current.
1	9·0	0·0066 amp.	1·22	1·00	1·00
2	9·0	0·0079 ,,	1·60	1·31	1·19
3	9·0	0·0109 ,,	1·80	1·47	1·65

From the above it will be seen that the rate of flow (as measured by tangent to curve) increases with the strength of the liquor. This fact is specially important for the following reason : In ordinary tanning operations it is well known that the greater portion of the gelatine is combined in the first month or so of the tannage, the remainder of the time being spent in tanning the middle layers and giving weight, owing to the increased resistance which the outer tanned portions offer to diffusion. Now, for reasons given earlier in the paper, it is necessary to use liquors of gradually increasing strength as the tannage proceeds, and which, for any given potential difference, give (as shown in curve B_2) an increasing hydrostatic pressure or head tending to force the liquor through the hide. Thus there is a kind of self-regulating arrangement—viz., as the mechanical resistance of the hide increases, so the endosmotic pressure increases to overcome that resistance.

The next experiments were made, using diaphragms of different materials and keeping potential difference and strength of liquor constant, the results being shown below :

Table C.—Nine volts. One per cent. solution of oakwood tannin.

Diaphragm.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Struck sole ...	0·0041 A	0·20	0·62	0·16
Porous clay ...	0·0066 ,,	1·22	1·00	1·00
Dressing hide..	0·0106 ,,	1·58	1·60	1·29

In the above will be noticed the great difference in mechanical resistance to diffusion between leather before and after it has been struck (*i.e.*, smoothed down and worked over with the striking pin) and rolled. The curious bending over of the curve for unstruck hide is due to the influence of the head of liquor and openness of the pores, allowing the liquor to run back again, a certain point being reached at which this leakage becomes equal to the flow, and the difference of levels remains constant. This effect is also shown with tap water and a porous clay diaphragm.

The next experiments were made, using liquors prepared from different tanning materials, and keeping the potential difference constant and using the same porous clay diaphragm, the results being shown below :

Table E.—Nine volts. One per cent. solutions.

Liquor.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Distilled water	0·00078	0·095	0·12	0·077
Shumac	0·0204	0·97	3·09	0·79
Oakwood extract	0·0066	1·22	1·00	1·09
Oak bark	0·0164	2·02	2·48	1·65

In the above, 10mm. difference of levels corresponds to 11·36 c.c. passing through the diaphragm, the levels in both compartments being the same on starting experiment.

II. and III.—Chemical Action.

II. To compare the precipitation of anhydride, etc., in solutions of tannic acid, when a current is passed through them, and when allowed to remain during the same time and under the same conditions, but without passing a current.

III. To determine the amount of tannin in the liquor before and after passing an electric current.

In carrying out the above, two beakers were taken, in each of which 150 c.c. of tan liquor (containing 5 per cent. oakwood tannin) was placed. Through the liquor in one beaker a current of 0·0086 ampere (measured by voltameter) was passed for $96\frac{1}{8}$ hours, and the other was allowed to stand open by its side, being thus under exactly the same conditions, excepting that it had no electricity passing through it. In the analyses given in Table F

33·4 c.c. of permanganate = 10 c.c. $\frac{n}{10}$ crystallised oxalic acid.

17·6 ,, ,, = 20 c.c. indigo carmine.

The same solutions were used throughout the above experiments ; 10 c.c. of a diluted solution (1-20th) were titrated with permanganate in presence of indigo carmine before and after treatment with hide powder. On examining the above results we may notice : (i.) The action of the electric current on bodies which are absorbable by hide powder. (ii.) The action of the electric current on bodies which are not absorbable by hide powder.

(i.) On comparing Nos. I. and IV. it will be seen that the total amount of tannin remains unaltered, or, if anything, to have slightly increased after the passage of the current. On filtering IV. and again analysing, it will be seen that some of the tannin

TABLE F.

No.	Description of liquor.	10 c.c. infusion.	10 c.c., after hide powder.	c.c. of non-tannin.	Tannin %.	Non-tannin %.
I.	Liquor before experiment ...	32·75	19·5	1·9	5·007	0·69
		32·70	19·4	1·8		
II.	After exposure, without passing electric current	32·50	19·55	1·95	4·88	0·72
		32·45	19·50	1·9		
III.	No. II., filtered ...	32·15	19·45	1·85	4·79	0·69
		32·15	19·45	1·85		
IV.	After passage of electric current and exposure..	32·5	19·0	1·4	5·073	0·54
		32·5	19·1	1·5		
V.	No. IV., filtered...	31·0	18·9	1·3	4·57	0·48
		31·0	18·85	1·25		

has been precipitated (see V.), probably as anhydride or phlobaphene. This precipitate, as seen from the experiment with the three-compartment cell, is produced at the cathode by the action of the hydrogen evolved there; this tannin is proved by column IV. to be still available for tanning purposes (after heating).

(ii.) This action is very marked, as will be seen from examination of columns 5 and 7 in table, the number of c.c. of permanganate consumed by these non-tannin bodies goes down from 3·7 in the original liquor to 2·9 in the unfiltered electrolysed solution, and to 2·55 in the filtered; this reduction is really greater than is apparent here, because the electrolysed solution was exposed to the air for exactly the same time as the other, and therefore the increase of 0·15 c.c. produced by exposure in the non-electrolysed should be added. This leads one to think that there may be a kind of restoration of the liquor, the tannin which has been decomposed by exposure to the air being reduced, possibly by the nascent hydrogen at the cathode; this would account for the reduction in the quantity of non-tannin matters, although, if these were more easily oxidisable than the tannin, the oxygen evolved at the anode might influence this result.

Summary.—The principal chemical actions of the current on tan liquor, using platinum electrodes at a current density of 1·6 amperes per square foot, are: 1. Precipitation of anhydride of tannin; this precipitate is more copious with a tannin capable of yielding "bloom," as shumac, in which case the electrical conductivity is higher (see Table E). 2. Reduction of the amount of non-tannin matters in the solution. The above shows that, at all events below current densities of 1·6 amperes per square foot, a limit which is never exceeded or reached in practice, there is no loss of tannin due to the action of the electric current, as the ratio $\left(\frac{\text{number of ampere-hours}}{\text{number of c.c. of liquor}}\right)$ in this experiment is considerably greater than that employed in practice—say, 366 : 1. I have found that the solubility of the precipitate decreases as the current density increases.

There is an effect (referred to earlier in the paper) which doubtless influences the rapidity at which the gelatine and tannin combine—viz., the molecular vibration of the liquid and hides, due to the phenomenon of electricity being a vibration of the ether, agitating the particles and making them combine with their affinities sooner than they would do if left to themselves. In support of this, the fact of tanning operations being accelerated by rise of temperature may be brought forward, heat being a similar vibration of the ether, differing only in period from the electrical vibration.

In endosmose, however, we have a perfectly tangible, measurable effect, propelling the liquor in the direction of the lines of current flow, tan liquor also being a particularly favourable medium for this purpose, for the following reasons: 1. The force increases with the percentage of tannic acid in the solution, thus falling in with the practical methods of tanning—*i.e.*, increasing as the permeability decreases. 2. The electrical resistance of tan liquor being high, the necessary difference of potentials (to the square of which the endosmotic flow is proportional) can be obtained between adjacent portions of the liquid without an undue expenditure of current, and therefore of energy.

We might approximately calculate how much tanning would be likely to pass through a 20lb. butt (tanned and dry wt.) in an hour, using, say, a 12 ampere current at nine volts, with proportionally larger electrodes, but keeping the distance between electrodes and hide the same as in experiment C with unstruck hide (it must be remembered that the leather in question was fully tanned, and, therefore, its permeability was at its minimum value).

Area of butt = 54″ × 66″ = 3,564 square inches.

Working area of diaphragm = 2⅝ square inches.

Tangent to curve near origin $= \frac{10\text{ mm.}}{6{\cdot}3\text{ hours}} = \frac{11{\cdot}36}{6{\cdot}3}$ c.c. per hour.

Current in experiment = 0·0106 ampere.

One gallon = 4,536 c.c.

Increasing the current to 12 amperes, and assuming (from Table A) that the flow is proportional to the current, we have $\frac{11{\cdot}36\times12}{6{\cdot}3\times0{\cdot}0106\times4{,}536} = 0.45$ gallon of liquor passing through the butt per hour; this, supposing the liquor to contain 4 per cent. of tannin, and to have a specific gravity of 1·02, would be equivalent to $\frac{0{\cdot}45\times10\times1{\cdot}02\times4}{100} = 0{\cdot}1836$lb. of tannin. If the butt require 20 × 0·45 = 9lb. tannin to tan it, then this amount would pass through in 49 hours. From the above it will be seen that having a means of bringing the liquor into intimate contact with the fibres of the hide, and also of assisting it to combine whilst passing through, we are in a much more favourable position than when working with only diffusion and capillary attraction to bring the liquor to the interior and replenish it when exhausted, especially as the tannage proceeds and the hide becomes less and less permeable.

In conclusion, I must express my thanks to the British Tanning Company, Limited, for facilities granted in carrying out experiments, and permission to publish results.

COMPANIES' MEETINGS.

NEW AUSTRALIAN ELECTRIC COMPANY.

A meeting of the shareholders of the New Australian Electric Company, Limited, Melbourne, was held on February 20 at the offices of the Company, Fink's-buildings, Elizabeth-street. Prof. W. C. Kernot presided.

The **Chairman**, in moving the adoption of the report and balance-sheet, said that the general position of the Company considering the bad times was certainly satisfactory. They had been making steady progress during the past year. Their lighting business had not been extended very much, but it had been consolidated and gaps had been filled up, while the business was on a footing as thoroughly settled and satisfactory as that of gas or water. A good deal of the supply was by meter, and the accounts were paid as regularly as gas accounts, and he ventured to say with much more cheerfulness. Unlike that of any other business, the income of their business had not been affected to any serious degree by the bad times of the past year and the disasters they had all witnessed, and some of them experienced. Of course he was now referring to the lighting business, which was the greater part of their business. Their manufacturing business they would not be surprised to hear had very much gone down. People could not pay for new schemes for electric lighting; but, as he had said, their lighting business was earning as much or more than it had ever earned before. Their financial position on the whole was very satisfactory. As they knew, their called-up capital was very small. Their total capital called up was, say, £22,000, whilst their assets amounted to between £70,000 and £20,000. That was to say, their two lighting stations, the plant, machinery, and stock were worth over £70,000. As a matter of fact, the capital on which they were working was very much larger than their subscribed capital. The working capital consisted, to a considerable extent, of loans on mortgage—£35,000 in round numbers. On all that money they were paying an average interest of 8 per cent. They were trying, but had not yet succeeded in getting that rate of interest reduced. In addition, they had largely reduced the amount due to outside creditors, and the result of their working was that all interest on mortgage loans had been paid, all other interest chargeable had been paid as well, and, as he had said, their indebtedness to outside creditors had been considerably reduced. He referred with regret to the death of Captain Rowan, who was a notable figure in connection with electric lighting in these colonies.

The motion was seconded by **Mr. E. J. White**, and carried unanimously.

Prof. Kernot and Mr. W. Brookes were re-elected directors, and the meeting was adjourned for a fortnight to enable Mr. R. C. Anderson, who had been nominated as a third director, to complete his qualifications for the position.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY, LIMITED.

An extraordinary general meeting of the above Company was held yesterday at Winchester House, Old Broad-street, E.C., to consider and, if thought fit, to pass the following resolution: "That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and that it is advisible to wind up the same, and that accordingly the Company be wound up voluntarily."

This resolution was not put to the meeting, but a long discussion took place on the management of the affairs of the Company, its present position and possible future capabilities. It was eventually decided to adjourn the meeting until Monday next, the 10th inst.

JOHANNESBURG LIGHTING COMPANY, LIMITED.

The second ordinary general meeting of this Company was held yesterday at Winchester House, Mr. W. G. Soper, chairman, presiding. The notice convening the gathering having been read,

The **Chairman**, in moving the adoption of the report and accounts, said that the Board would have been more happy had there been a profit. The consumption of gas showed a marked

Cr.	Public lighting. £	s.	d.	Private lighting. £	s.	d.
Sale of current by meter	—			5,576	8	5
Revenue under contracts	4,317	9	4	—		
Meter rentals	—			177	10	1
Transfer fees	21	12	3	27	0	3
Interest and dividends	105	17	11	132	7	5
Discounts on materials for generation purposes	29	18	0	37	7	6
Total receipts	4,474	17	6	5,950	13	8
Total of public and private				10,425	11	2
Balance, being loss on public lighting for period, carried to net revenue account				706	18	1
				£11,132	9	3

Dr. Net Revenue Account.	£	s.	d.
Balance from revenue account (loss on public lighting)	706	18	1
Balance, being net revenue to period, carried to balance-sheet	434	6	7
	£1,141	4	8

Cr.	£	s.	d.
Balance from revenue account (profit on private lighting)	1,141	4	8
	£1,141	4	8

General Balance-sheet as at Dec. 31, 1892.

Dr. Liabilities.	£	s.	d.
Capital account	480,126	0	0
Sundry tradesmen and others, due on construction of plant, machinery, fuel, stores, etc.	14,764	6	3
Sundry creditors on open accounts	4,226	8	5
Net revenue account—balance at credit thereof	434	6	7
	£499,551	1	3

Note.—Under existing contracts relating to the equipment of the stations and other works, there are contingent liabilities which become due only after completion and final acceptance of the work.

Cr. Assets.	£	s.	d.
Capital expenditure	448,163	12	9
Stores on hand	7,283	14	3
Sundry amounts paid on account of building contracts in course of completion	10,477	0	0
Expenses of issues of ordinary and preference shares (less premium received)	2,582	13	2
Sundry debtors for current supplied	8,616	18	8
Other debtors	3,674	12	2
Cash at bankers and at call	11,747	0	0
Cash in hand	4	9	6
Sundry deposits under provisional orders, etc.	7,001	0	9
	£499,551	1	3

BUSINESS NOTES.

Great Northern Telegraph Company.—The receipts for the month of March were £22,000.

Western and Brazilian Telegraph Company.—The receipts for the week ended March 31 were £2,339.

Eastern Extension Telegraph Company.—The traffic receipts for March amounted to £46,204, against £43,805.

Direct Spanish Telegraph Company.—The receipts for the month of March were £88 less than for the corresponding period.

Cuba Submarine Telegraph Company.—The receipts for the month of March were £162 more than for the corresponding period.

Eastern Telegraph Company.—The receipts for the month of March were £55,786, as against £59,037 for the corresponding period.

Scotch Collieries.—The Shotts Iron Company have fitted up the Burghlee section of their Loanhead collieries with electric light.

Leyton.—The Leyton Local Board have been advised by the Board of Trade to apply for a provisional order instead of a license.

Accrington.—A "Gas Examiner," writing to the Accrington paper, urges that as gas will continue to be profitable, the town ought to purchase the gasworks and provide both gas and electric light itself.

Gartloch Asylum.—A meeting of the City of Glasgow District Lunacy Board held last week resolved by a majority that the Gartloch Asylum, now in the course of erection, should be lighted by electricity.

Renaison.—The town of Renaison (Loire) is to be equipped with a station by the Compagnie Centrale de l'Electricité, of Lyons. This company is now negotiating for a concession for the construction of an electric tramway between Renaison and Roanne.

Llandudno.—Mr. Jas. McMaster is of the opinion that Llandudno would do well not to have a chimney 150ft. high "belching vapour at the very period when the visitors resort to the town," but that all the water power required can be obtained.

Personal.—Mr. W. Farrars has resigned his post with the Corlett Electrical Engineering Company, of Wigan, and joined Messrs. Rosling and Matthews, of Bradford. Mr. Farrars had been commercial manager for Mr. Wilson Hartnell for the last 11 years until last July.

Carbons.—A new carbon factory is to be erected at Nanterre for the manufacture of the Schmelzer carbons, which are well known in Germany, and are there made by a Nuremberg firm. The title of the new concern is the Compagnie Française de Charbons pour l'Electricité.

City and South London Railway Company.—The receipts for the week ending April 2 were £744, against £796 for the corresponding period of last year, or a decrease of £52. The total receipts for 1893 show an increase of £995 over those for the corresponding period of 1892.

Electric Fire Bells at Poole.—Councillor Walmesley called attention of the Poole Town Council at the last meeting to the fact that a large number of the electric bells for calling the members of the fire brigade together were out of order, and the matter was referred to the committee.

Crieff.—There is the probability of the electric light being introduced in the town of Crieff, N.B. The town, as regards an ample supply of water, is singularly favoured for the purpose. It is reported that Provost Adie is making careful preliminary enquiries as to the expense and the probability of success.

Edinburgh.—At a meeting of the Edinburgh Merchants' Association fixed for Wednesday night a motion was submitted: "That in the matter of the electric lighting of the city, this association petition the Town Council not to take up the matter, but to hand over the working of it to a public company to carry out."

Traction Syndicate, Limited.—This Company has been registered by Faithfull and Owen, 11, Victoria-street, S.W., with a capital of £10,000 in £100 shares. Object: to acquire, develop, and turn to account certain patents, particulars of which are not given. The first directors are to be determined by the Company in general meeting.

Mix and Genest, Limited.—This Berlin Company, with branches in London and Hamburg, proposes, after carrying forward and writing off various amounts, to pay a dividend for 1892 of 6 per cent. The London branch, states the report, is doing well, and the German goods are being bought in preference to those of English make.

Electro-Medical Supplies.—We have received from the General Electric Company the third edition of Section O of their catalogue of electro-medical supplies. It contains illustrations of a number of medical coils in compact form, some with the "E.C.C." dry Leclanché cells, plate electrodes, cautery outfits, electric surgeon's lamps, batteries, and telephones.

Aberdeen.—Prof. Kennedy, who is acting as adviser to the Aberdeen Town Council on the scheme for electric lighting, was engaged last week, along with Mr. Alex. Smith, superintendent of the Gas Department, finally revising the plans, preparatory to inviting contracts for the work Before bringing his visit to a close, Prof. Kennedy also inspected the route along which the wires are to be laid.

Moss Side.—The works in connection with the electric lighting of Moss Side, Manchester, will be begun in the course of the next few days. The local authorities hope to have the new light in the Whalley Range residences as well as in the principal shops and streets by next winter. A telephonic exchange will shortly be established in the township, the wires being placed underground instead of overhead.

Sheffield.—In consequence of ill-health, Mr. John Tasker, the chairman of the Sheffield Electric Light Company, has resigned his seat upon the board. A resolution was passed at a meeting of the directors, held on Wednesday, regretting the cause of Mr. Tasker's resignation, and thanking him for his past services. Mr. George Franklin was elected chairman in his stead, and Mr. W. S. Laycock, Ranmoor, was elected a director to fill the vacancy on the board.

Cardiff Chimney.—At a special meeting of the Lighting Committee of Cardiff Corporation held last week tenders were opened for the construction of the gigantic chimney to be erected at the electric light works to be built on Keckwith Common. The tender of Messrs. W. Thomas and Co., West Bute Dock, Cardiff, amounting to £2,967, was accepted. It is, however, subject to certain deductions for simplification of design agreed to by the committee.

Tenders Open.—The small town of Znaim is to be provided with a central station. The work, which will comprise only about 1,500 incandescent lamps, will be put up for public tender by the Stadtgemeinde, Znaim, Moravia. For the erection of a station at Nagy-Karoly offers have been received from Ganz and Co., B. Egger and Co., and Siemens and Halske. It is, however, not intended at present to seriously consider these offers, but to ask contractors to compete for the concession.

Liverpool Overhead Railway.—At the last meeting of the Mersey Docks and Harbour Board the Works Committee recommended the Board to allow the Liverpool Overhead Railway Company to erect an additional flight of stairs at the terminal station at the Herculaneum Dock. Mr. Glynn, in moving the adoption of the recommendation, said he was glad to note that the company already had so many passengers to carry that they required an extension of their accommodation. The motion was approved.

Heckmondwike.—A public meeting was held last week at Heckmondwike, promoted by members of the Local Board who advocate the adoption of the electric light in the town. Mr. S. Wood presided, and there was a large attendance. The chairman and Messrs. A. Rhodes and T. Redfearn spoke at length. A resolution was eventually adopted with practical unanimity approving the scheme, and pledging the meeting to support the four candidates at the approaching Local Board election in favour of it. The four retiring members are against the project.

Salford.—The Salford Gas Committee are prepared to receive tenders for the supply and erection of machinery for their electricity supply works. Copies of the specifications, which are in the following sections—viz., (Contract No. 2) Steam-boilers, etc.; (3) steam-engines, pipes, travelling crane, etc.; (4) electrical plant; (5) electrical mains, etc.—may be obtained, on payment of the sum of £5 for each section, which will be returned on receipt of a *bonâ fide* tender, from the Gas Engineer, Gas Offices, Salford. Full information may be obtained on application to the electrical engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. The tenders must be sent in by May 4.

Whitehaven.—The Electric Lighting Committee of the Whitehaven Trustees have agreed to recommend that the tenders of Messrs. Siemens Bros., London and Manchester, be accepted, for the providing and laying of the conductors at Whitehaven. It is stated that the trustees will save something like £1,100 as compared with the contract of the Okonite Company, which has fallen through. The plans and specifications show that provision is made for lighting the whole of the street lamps throughout the district with incandescent lamps of various candle-power up to not exceeding 32. These will be placed in the present lanterns. The area of domestic supply will be practically some 50 yards on either side of the distributing main up King-street.

Falkirk.—At a meeting of the Falkirk Town Council held last week, there was submitted a report by Mr. Neilson, sanitary inspector, on a proposal to light the town hospital with electricity. The report stated that a large number of electrical engineers had been consulted on the subject, and that the plan proposed, to have the dynamos driven by the engine at present in use for pumping water to the hospital, was considered practicable. The inspector also stated in his report that he had at the same time made enquiry as to the possibility of lighting the principal streets of the town with electricity, and he submitted a scheme dealing therewith, by which it was proposed to obtain the motive power from a turbine wheel to be erected at the waterworks. The report was held over for further consideration.

Dundee.—The Finance Committee of the Dundee Gas Commission has passed a number of accounts in connection with the introduction of the electric light into Dundee. It has resolved to pay Messrs. Urquhart and Small, the electrical engineers, an additional sum of £400 to account of their commission. For furnishings for the electrical department, expenditure to the extent of £79. 4s. has been incurred. For work done and for apparatus provided at the station, accounts for £4,490 have been passed, including £1,131 to the Callenders Bitumen, Telegraph, and Waterproof Company, as a second instalment of their account for constructing culvert and laying copper strip therein; £750 as a fourth instalment to Messrs. Whyte and Cooper for boilers and condensers; £140 as a third instalment to Mr. John Scott's account for joiner work; and £2,368 as the first instalment to Messrs. Siemens Bros. and Co. for dynamos.

Coventry Tramways.—The General Works Committee of the Coventry City Council at the meeting last week presented a draft agreement between the Corporation and Mr. Graff Baker with respect to the electrical equipment of the tramways. The Mayor, in moving the adoption of the report, said the agreement would put an end to a long-standing dispute. He thought it had been an advantage to the Council to have postponed the matter from the last meeting, because some desirable changes had been made. The committee had done their best to make the appearance of the streets as little objectionable as possible. Mr. James called attention to one of the paragraphs in the agreement by which the Corporation, at the expiration of each completed period of two years from the opening of the line, might call in the services of an arbitrator for his opinion upon the state of the repair of the line. He thought this was rather a long time, because the line would need repairing more frequently than every two years. As regarded the powers of purchase, he thought it was undesirable that any price should be named, and was rather surprised to think they would want to buy a tramway to Bedworth. He would leave the question of purchase open altogether. The Mayor said with regard to the maintenance clause, two years was not a long time for the tramways to get out of repair. As to the purchase, it was thought better that a definite sum should be named, and it was quite within the power of the Council to decline to purchase.

Chatham.—The directors' report of the Chatham and Rochester Electric Lighting Company, to December 31, 1892, announces a profit upon the actual generation of the electric light of £62. 5s. 5½d. The directors were in hopes of being able to declare a dividend on the past half-year, but as the profit has only been made upon the last quarter it is not sufficient. They are, however, of opinion that they will be able to declare an interim dividend in June next. This is practically owing to their having secured the services of an eminently qualified electrical engineer in the person of Mr. Mark Henry Hurrell, M.I.E.E., who has been appointed managing director, as the profit that has been made has been effected during the latter part of the year since Mr. Hurrell's appointment. In consequence of the severe frost and heavy rains the main circuits have been delayed, but they are now rapidly approaching completion. A great part of the new machinery is in course of erection at the central station, and the sub-stations are ready to receive the transformers which are now lying at the works ready to be placed in position. The directors desire to inform the shareholders that a communication has been received from the Corporation of Chatham enquiring if the company are disposed to sell the undertaking to the Corporation, and on what terms. In the interest of the shareholders, the directors considered it was inadvisable to enter into negotiations at present, and have informed the Corporation that when the works in progress are completed they will be willing to receive a deputation to inspect the same and to confer further upon the subject. This report was adopted at the meeting of shareholders.

Eastbourne Electric Light Company.—The report of the Directors, submitted to the shareholders at the ordinary general meeting this week, is as follows: "The Directors, in presenting the accounts of the Company for the year ended 31st December, 1892, congratulate the shareholders upon the fact that for the first time since the Company's incorporation a sufficient profit has been made to permit of a dividend being paid upon the ordinary shares. This is due to the steady increase of the Company's business, coupled with the exercise of proper economy in the working of the concern. The profit available for dividend is £431. 7s. 2d., and out of this the Directors suggest that £3 per cent. per annum shall be paid upon the subscribed share capital as for the year ended 31st December, 1892. This will absorb £317. 2s. and leave a balance of £114. 5s. 2d. to be carried forward as a reserve. Since the last general meeting the Directors have purchased the freehold of the works in Junction-road for £5,600. The money was provided by an overdraft at the London and County Bank, secured by a first charge upon the works and by a mortgage to Mr. Gosden for £1,600. This will explain the heavy outlay on capital account on the one side and the overdraft at the bank on the other. A considerable saving in rent has been effected by the purchase. The Directors have now under consideration the extension of the circuits to the Upperton district, where they have ascertained the light is greatly desired. They have also accepted a contract with the Corporation for increased arc lighting on the sea-front, and other extensions of the Company's business can now be entered upon to great advantage; but this increase of business will need additional capital, and a prospectus for this purpose will shortly be issued. The whole of the Company's plant, machinery, and mains are in excellent condition."

Brighton.—The Brighton Town Council have succeeded in preventing the Brighton Electric Lighting Company from getting further powers from the Board of Trade. Mr. Ingram B. Walker and Major Cardew, R.E., who recently held an enquiry at the Brighton Town Hall, have reported to the Board of Trade, briefly recounting the arguments submitted to them. In their "conclusions" the inspectors remark upon the extensive and satisfactory supply of the company, and say that there is force in Mr. Hammond's contention, that the inactivity of the Corporation previous to 1889 justified him in treating their statutory powers, obtained in 1883, as having expired, and consequently in expending further capital. "It would also seem as if this view were at one time held by the Corporation, for in 1891 negotiations for purchase were so far advanced that terms were agreed upon between the company and the Lighting Committee of the Corporation." They pointed out, however, that since 1889 there can have been no longer any doubt as to the intentions of the Corporation, and that when the works now in hand are completed the Corporation will possess nine miles of mains, capable of carrying 60,000 eight-candle lamps; and, after quoting the provision that no order shall be granted except with the consent of the local authority, unless there are exceptional circumstances, state that, while they are of opinion that "the company have some claims upon the consideration of the Corporation," they cannot recommend the Board of Trade to dispense with the consent of the Corporation. They think the allegation that the Corporation will be unable to afford a satisfactory supply was not proved, and state that the suggestion that the local authority will not be able to conduct their operations at a profit is a matter for the decision of the ratepayers. Acting on this report, the Board of Trade have decided not to grant the provisional order applied for. The Brighton Company have now a Bill before Parliament with the object of obtaining further powers.

Mansion-Lighting.—A large and complete installation of the electric light has been successfully carried out at Goodrich Court, Monmouthshire, the large mansion owned and occupied by Mr. H. C. Moffatt. The prime motors are two oil-engines (Spiel's patent) of 10 h.p. and 2½ h.p. respectively, driving on to a 3in. countershaft, which in turn drives a Goolden dynamo, having an output of 130 volts and 70 amperes, at a speed of 1,100 revolutions per minute. The current is conveyed from the engine-room (situated at the base of the hill) to the cell-room at the Court, a distance of 230 yards, by means of $^{19}/_{12}$ cables of high insulation laid underground in three-way bitumen cases, and no little difficulty was experienced in laying the casings and making watertight joints on account of the steep gradient. This current charges a set of Epstein accumulators, 54 in number, capable of storing sufficient energy for from three to four days' ordinary consumption, the actual storage capacity of these cells being 600 ampere-hours. The lamps number about 250 and are fitted in the most effective and artistic manner. The light is remarkably steady and brilliant, and presents a marked contrast to the gas and oil formerly in use. The whole of the indoor arrangements will be under the sole management of the butler, who has charge of the four large double-pole switchboards which control the various circuits, whilst the care of the engines is entrusted to the estate carper ter. When the consumption of current is normal it is only necessary to run the large engine for five hours for charging purposes twice a week, and the amount of oil used by the large engine at full load being at the rate of 1½ gallons of benzoline per hour. The actual running cost is very small, being merely the cost of the benzoline, which at 1s. a gallon is equivalent to a weekly expenditure of 15s. plus waste and occasional lamp renewals. This is a vast improvement on the method of lighting by gas from the absence of ill-effects on the valuable decorations and paintings. The materials employed throughout the installation are of the highest quality and finish, and the whole of the work has been carried out under the direct supervision of Mr. J. B. Cumberland, electrical engineer to the firm of Messrs. W. O. Rooper and Tozer, electrical engineers, of Northampton and Stafford, who have already lighted many country houses by electricity.

Halifax.—Mr. T. P. Wilmshurst, the recently-appointed electrical engineer to the Halifax Corporation, has presented a report to the Town Council, in which he recommends the adoption of the system known as "alternating current at high pressure." He points out that this system has during recent years made enormous strides in all parts of the world, and that out of some 58 systems at work or in course of construction in the United Kingdom more than 40 are operated on this system. It has been adopted by the Corporations of Huddersfield, Portsmouth, Worcester, Dublin, and Bristol. He remarks that the system is an economical one is best evidenced by the substantial dividends which are already being paid by companies working on it, and as to its reliability the best evidence is that in the great majority of stations breakdowns are practically unknown. He is in favour of the old Salvation Army barracks in Stead-street, where a substantial building belonging to the Corporation is already erected. It is conveniently situated as regards the compulsory area, and also with regard to future extension of the town, which will probably take place in a southerly and westerly direction. The present building would accommodate, by a compact arrangement of vertical engines and rope-driven dynamos, eight engines each driving 100-unit dynamo, 20 engines driving 50-unit dynamo, and four engines each driving 50-arc light dynamo; also six boilers, each of 250 h.p. This would probably be sufficient for 50,000 to 60,000 8-c.p. lamps wired. He recommends that throughout the streets mentioned in the provisional order as the compulsory area high-pressure mains should be laid, and that two sub-stations, one near the Town Hall and one near the Post Office, should be erected. From these low-pressure cables would radiate, supplying current to the principal adjoining streets. If laid on the plan suggested, the high-pressure mains and the low-pressure cables sufficient for present requirements, and the piping for low-pressure mains throughout the area, would probably cost not more than £12,000. He recommends the laying down, in the first instance, of the following plant: Three boilers, two engines and dynamos, each of 100 units, and one engine of 50 units, thus providing for 5,000 8-c.p. lamps burning at once, and the boiler power for 10,000 lamps, with ample reserve in each case. The total estimated cost of this plant is put down at £23,600. It is also urged that a small scheme of street-lighting by electricity should be carried out in the more central streets, as it would render the town more attractive, and would popularise the electric light and assist its spread.

Shoreditch.—The *Globe* has, in its issue of the 6th inst., an article on electrical progress, in which it calls the attention of other municipalities to the action of Shoreditch in establishing electric light supply. St. Pancras had brought the power supply within the reach of all, charging 3d. a unit. But the Shoreditch people will be better off even than this, for they will probably be able to buy electric power at 2d. per unit, which will be about equal to gas at 15d. per thousand cubic feet. The article continues: "It will pay any manufacturer who now employs a gas-engine in his work to dispose of the engine at half its original cost, or even less, and to purchase with the proceeds of such sale an electromotor, which will do the same amount of work for him, and will cost him considerably less for running expenses. Moreover, there will then be no engine to require attention, for the motor will derive its current from the wire led into the premises, and will be controlled by a simple hand-switch at a touch of the finger. The striking feature of the Shoreditch scheme, shortly to be carried into effect, is the utilisation of the dust refuse as fuel for the generation of steam wherewith to actuate the dynamos and produce electricity for both light and motive power. The consumption of the ashbin refuse will likewise serve to heat water for the public baths and washhouses, so that a saving will be effected in more ways than one. The St. Pancras authorities had to expend £2,306 last year on coal alone, and this item constituted rather more than one-third the total cost of their electricity production. Fuel cost them seven farthings per unit, out of a total cost per unit of a fraction under 5d. Thus it is not at all unreasonable to expect that the St. Leonard's (Shoreditch) Vestry will be able to sell electricity for lighting at 4d. per unit, which is cheaper than it is sold anywhere in the United Kingdom, and is equivalent to gas at 2s. 6d. per 1,000 cubic feet. Even at Newcastle-on-Tyne, with abundant coal close by, the rate is as high as 4½d. The collection and disposal of the ashbin refuse now costs £3,000 per annum in St. Leonard's parish, but when burned in the destructor it will merely cost £1,250 for collection, and thus £1,750 or thereabouts will be saved annually. Used as fuel for generating electricity, it will take the place of coal to the extent of £1,200, and in heating water for the baths also, to the extent of some £500 more, so that the total saving to the parish may be set down at £3,450 per annum. The proposal at first sounds almost too good to be true, but there can be no real doubt of its feasibility, and the adoption of the scheme marks a new departure in economic lighting by the new illuminant. The Shoreditch region ought to prove an excellent field for the general adaptation of electricity on a commercial basis, because the shops keep open late every night, at a vast outlay for gas, and there is no slack season. Private residents, too, do not leave town for long periods, locking up their houses half the year and consuming no light, as the more fashionable dwellers in the West are apt to do. The demand, once established, is sure to be continuous. It is possible that the vestries of St. Pancras, Shoreditch, and Islington may ultimately arouse not a little envy in other quarters of London where no effort is made to retain such a source of income in the hands of the parochial authorities, and public lighting companies are allowed to obtain possession of the field."

Guildford.—At the meeting of the Guildford Sanitary Authority last week, the Electric Lighting Committee reported that they had considered the report of Mr. J. N. Shoolbred on the subject of electric lighting in Guildford, and they had obtained information as to the probable cost of a provisional order for the supply by the Authority of electricity in the district, and they found that the cost of obtaining a provisional order was (approximately) £300. The committee had come to the conclusion that the Council would be best advised not to withhold their consent to the grant by the Board of Trade of a provisional order for supplying electricity in the district by a private company providing that conditions satisfactory to the Council could be arranged, and that the usual provision was inserted in the order for the sale to the Council of the undertaking upon equitable terms and within a reasonable period, and they recommended that a reply to this effect should be given to the gentlemen who approached the Council on this subject. This report was signed by W. Swayne (mayor), John Cable, W. Wells, R. Salsbury, H. Peak, Richd. Mason. Mr. Cable moved the adoption of the report. It would be remembered that the Authority was approached by a number of gentlemen belonging to the town with regard to the electric light. No answer had as yet been given, and it was because of that that the latter clause was inserted. They felt that they ought not to act any longer as the dog in the manger, but that they should allow a company to start supposing they made arrangements that it would not ultimately become a monopoly in the town, as the gas company had been. He believed that some such arrangement as that would meet with the general approval of the town. Mr. F. Wheeler, in seconding, said that Mr. Cable's explanation as to the paragraph about the private company had allayed his fears. He at first feared that the committee were willing that a regular trading company should undertake the lighting. Mr. M. Colebrook was sorry to see the report worded as it was, because he should have liked to have seen the Corporation take the matter in hand, and do the lighting themselves. They would have the Town Mills in hand before long, and he understood that part of the reason for keeping the electric lighting back so long was to first obtain the mills, and that then the Corporation would have gone into it and done it themselves, giving the ratepayers the benefit of any profit which might be derived from it, and having the whole and sole control of it, not at some future date, but at the commencement. Mr. Wrist also thought that the object foremost in their minds in endeavouring to secure the mills was for the purposes of the electric light. Mr. Taylor said he regretted the second paragraph of the report. He thought it would have been advisable if the committee had taken a little more time to consider before abandoning altogether the idea of the Corporation lighting the town by electricity. He was impressed with the fact that the negotiations for the Town Mills were based on the supposition that they were likely to carry out electric lighting. The second paragraph seemed an entire abandonment of the idea of the lighting being done by the Corporation, which he regretted very much. He was unwilling to abandon the idea, as he thought the Corporation ought to take the lighting in their own hands. Mr. H. Peak said that the committee would, he was sure, be glad to hear the strong expressions in favour of the adoption of the electric light. The committee were also in favour of it, but when certain figures were put before them they felt that it was a matter which could hardly be dealt with at present, although the time was certainly coming when Guildford ought to have the electric light, as many towns of less importance had already got the light. He did not think, however, that the members of committee had any idea of the matter being entirely shelved. He certainly had no such idea, but the committee were informed by the clerk that any company proposing to get a provisional order would first have to apply to the Corporation, and that entirely altered their feeling in the matter. No company could introduce the electric light as a private company, hoping to make it a paying concern, without first getting the consent of the Corporation to do so; therefore, they were not put quite in the position which one or two gentlemen seemed to consider. He hoped the time would shortly arrive, when they would see the electric light properly established in Guildford. The Mayor said the Corporation had only received the one application. The committee had spent a great deal of time in considering the matter, but they could not see their way to adopt the electric light at present, in consequence of its being such an expensive undertaking. Mr. Salsbury said the committee felt that, considering the large amount of money they were already pledged to spend in the next few years, they were not at present justified in increasing the burdens of the ratepayers. If they went in for it at all they would have to go in for it thoroughly, which would mean a cost of £25,000 or £30,000, and he did not think they could at present recommend the Council to spend that money. The Town Clerk said that the application received in November, 1891, from some gentlemen of the town, was to lay pipes across or under streets without their obtaining any parliamentary powers, and he was prepared from the beginning to advise the Authority that they had no power to grant such an application. With regard to the consent of the Authority being necessary to the obtaining of a provisional order, it was perfectly true that the Board of Trade had power to dispense with that consent if under circumstances they thought it necessary, but it would require a very strong case to induce the Board of Trade to dispense with it. Mr. Colebrook thought, after the discussion which had taken place, that the time was not quite ripe for undertaking the lighting of the town by electricity, and he considered it would be best to refer the report back to the committee, who could bring another report before the Authority if they obtained any fresh information. He moved an amendment to this effect, which was, however, defeated. The original motion was then carried.

Birkenhead.—At a special meeting of the Finance Committee of the Birkenhead Town Council on the 24th March the report of the special sub-committee appointed to consider the question of the transfer of the Birkenhead Electric Lighting Provisional Order, 1890, was submitted. The report, a most interesting and complete one, stated that in the year 1882, when the Electric Lighting Act was passed, the Town Council of Birkenhead, in order to keep the power of supplying electricity to the public in their own hands, applied to the Board of Trade for a provisional order, but as the only form in which the Board would issue the order was, in the opinion of the Council, of an altogether objectionable and impracticable character, further action in the matter was dropped for the time. In 1888 a further Act was passed which amended in many important details that of 1882, but prescribed that a company supplying electric light to any district should have a monopoly of the right for 42 years. To prevent this a provisional order under the Act was applied for by the Corporation, and in 1890 they obtained such order, conferring upon them certain rights and powers. Under the order the Corporation were within a period of two years after the commencement of the order (now long since expired) to lay down mains, etc., to supply electricity within a certain prescribed area. It thus happened that the Corporation were already, so to speak, in default as regarded the carrying out of the works contemplated by the order, and it was now within the power of the Board of Trade to revoke the order altogether, but having regard to the whole circumstances, and the *bonâ fide* action the Corporation had taken since they became possessed of powers, the special sub-committee were not apprehensive of losing these powers immediately. Eventually the Council referred the matter to the Finance Committee to consider and recommend the Council as to the steps to be taken. Enquiries and negotiations were carried on, the majority of the sub-committee being inclined to bring about a transfer of the powers of the Corporation to a company, provided terms favourable to the town could be obtained which would also be acceptable to the Board of Trade. The sub-committee were in favour of bringing about an agreement with the Brush Electrical and Engineering Company, Limited, whereby the Council could again obtain possession of the provisional order and the undertaking established under it from the local company at the end of a period of 21 years instead of 42, on the basis of purchasing the work with value for goodwill, etc. They were also in favour of an equal division of the profits between the Corporation and the company, after allowing for depreciation, maintenance, and accumulative profit to the company of 10 per cent. However, during these negotiations the sub-committee had been watching the development of the various systems in use, and had noted the action taken in other towns, and they gradually came to the conclusion that it would be unwise to recommend the Council to part with their powers, having regard to the fact that serious difficulties might arise in connection with a transfer to a company even if terms were agreed to on both sides. In arriving at this conclusion the sub-committee were guided by the facts that: Experience had shown that electricity could be produced so as to pay a profit, and it was not unreasonable to anticipate a reduction in the present costliness of production and supply; a large number of corporations and public bodies have now taken up the powers conferred upon them by their orders, and at the present time are supplying electricity within their districts with favourable results, and in some instances the results financially have been very satisfactory; a corporation supplying electricity retains control of the streets; in the case of a corporation the management is voluntary and not by means of a paid board of directors; a corporation can borrow money as a rule on more favourable terms than a company; corporations owning gasworks and supplying electricity would be able to make favourable terms with regard to fuel and the delivery of coal, and perhaps the electric works could even in some instances be enclosed and included within the gasworks premises, and there need be no fear of undue competition between gas and electricity, both of which might be pushed to the utmost with advantage, and in the event of the depreciation of the one undertaking the other would improve, and the ratepayers would obtain the advantage either way. The sub-committee, therefore, recommended "That having regard to all circumstances it is undesirable to continue negotiations for the transfer of the powers of the Corporation under the Birkenhead Electric Lighting Order, 1890, to any company body, or person, and that the Council should itself carry out the provisions of the Birkenhead order." Unless the Council determined to proceed to carry out the provisions of the order, and to supply electricity within the borough without undue delay, in all probability the Board of Trade would withdraw from them the powers they now possessed, and it was most likely that powers would be conferred upon some company which would be prepared to supply electricity to the exclusion of the Corporation for a period of 42 years. The report concludes: "To sum up the position of affairs, the Council have two courses open to them. They can carry out the order themselves, and if they determine to do so no time should be lost in taking action. This course the special sub-committee unhesitatingly recommended, or they can, perhaps, agree with some company for the transfer to such company of their powers under the order. This course would, in the opinion of the special sub-committee, be unwise. If neither of these courses are adopted, the Council will most certainly lose its powers, and will be practically helpless in the event of a company applying to the Board of Trade for an order to supply electricity within the borough, though, of course, in this case, an attempt could be made to obtain some clauses and provisions for their protection, and for the protection of the interests of the public. After considering this report, the Finance Committee resolved that the report be adopted, and that the Council be recommended to authorise the committee to proceed to carry out the provisions of the order of 1890, with power to call in experts, engineers, and advisers, and to take all necessary steps in the matter."

Scarborough—Report by Mr. Bernard Drake.—At the meeting of the Scarborough Town Council on the 29th ult., the Sanitary and Lighting Committee reported that they had met on March 23, and considered the minutes of meetings of the Electric Lighting Sub-Committee held on the 15th and 20th days of March. This committee reported that, on the former date, they received the following report from Mr. Bernard Drake, explaining why he reported in favour of a pressure of 2,000 volts:

General System.—The system of laying the mains in cast-iron pipes with junction-boxes at intervals is, I consider, the best that could be adopted, as it enables additional cables to be drawn in or repairs effected without disturbing the roads. Any system of sheathed cables or conductors run in with bitumen, as used at Liverpool and elsewhere, necessitates the roads being broken whenever any extension is required. It is very desirable that an efficient system of ventilation of the pipes should be provided, to which point no reference is made in the company's letter. If possible, a continuous current of air should be forced through the pipes, which will effectually remove any danger from the accumulation of gases, and prevent the mildewing of the conductors.

Transformer-Boxes.—I approve of the general arrangement of transformer-boxes, and I consider it advisable that these should be sunk in the streets wherever possible, but I must take exception to the iron covers which it is proposed should be let in flush with the pavement. Although I am aware that these are permitted in some towns, it is found that the roughness of the plates soon wears off, and they become a source of danger, especially in wet weather. At the end of Clause 9 in the Scarborough provisional order will be found the following: "Every such box, including the upper surface or cover thereof, shall be constructed of such materials, and shall be constructed and maintained by the undertakers in such a manner as not to be a source of danger, whether by reason of inequality of surface or otherwise" Under this heading I would suggest that the company be requested to construct the cover of all transformer-boxes and junction-boxes in the form of a frame filled in with rough cement, wood blocks, asphalte, or other approved material, the ironwork which is flush with the pavement to be reduced as far as practicable and suitably roughened. I may add that this system is insisted upon in London, and the necessity would be much greater in a hilly district such as Scarborough. I enclose a tracing showing this modification.

Safety Fuses.—No details are shown as to the safety fuses to be provided. There should be fuses of approved length and construction in both the positive and negative poles of the primary and secondary circuits before they leave the transformer-boxes; also each transformer, or in the case of low-tension network, each bank of transformers should be fitted with appliances as prescribed by the Board of Trade to put the system to earth in the event of any accidental connection being established between the primary and secondary circuits. No such arrangement is shown in the details forwarded to me.

Route of the Cable.—I should advise the cables being run under the footpaths in preference to the carriageways, as this has been found elsewhere to be preferable. In the first place, the tents which have to be erected round the junction-boxes while connections are being made, or alterations effected, would interfere with the carriage traffic; and, secondly, it is more difficult to keep the junction-boxes, etc., in efficient repair if subjected to the heavy traffic of a road. The cable should be carried from the generating station by such a route to the compulsory area and other parts of the town, as will reduce as far as possible the loss in transmission and the consequent risk of inequality produced in the lights. No doubt in time the company will avail themselves of the rights granted to them under the provisional order, by laying the service mains in all the principal streets as application may be made from time to time by consumers, but in arranging the course of the first mains, the above consideration should be borne in mind. I may say that, as far as I can judge without paying a special visit for the purpose, the route shown in the enclosed plan is satisfactory, but I should prefer that the Corporation should consult with their borough surveyor on this point.

Cables.—The insulation resistance of the primary cables mentioned in the company's letter should be sufficient, but it will be advisable to stipulate that every length of cable shall be individually tested in the tanks before leaving the works, and a record of these provided if requested. I should be glad to have a sample of the fuses it is proposed to use, and a detailed drawing showing how these are attached to the transformer, and the cables led from them to the primary and secondary circuits. The questions, however, relating to these samples, and also to the fuses and safety apparatus, need not delay the laying of the pipes, which I see your enclosure have already been delivered. I need hardly say that every effort should be made to get the laying completed, and the roads made good, before your season commences.

The town clerk was then instructed to write Mr. Drake and point out to him that in the agreement between the Corporation and the Scarborough Electric Supply Company, Limited, it is provided that "wherever the consumers are sufficiently close to one another the distribution shall be by means of low-tension mains fed from sub-stations," that no sub-stations are shown on the plans submitted by the company to the Corporation, or referred to in the letter received from the secretary of the company, or in Mr. Drake's report of March 2nd, but that transformer-boxes are mentioned in the secretary's letter and Mr. Drake's report, and ask Mr. Drake if transformer-boxes are the same as sub-stations, and if not, what is the difference between them, and if there is any difference between transformer-boxes and sub-stations, whether the former answer the same purpose and are equally as efficient as the latter. The meeting was afterwards adjourned to March 20th, when the members of the sub-committee met and considered a letter from Mr. Bernard Drake in reply to the town clerk's letter of March 15th, and also the plan sent in by the Scarborough Electric Supply Company. It was then resolved that the committee recommend that Mr. Bernard Drake's report of March 2nd be approved and adopted, and that the town clerk be instructed to send a copy of Mr. Drake's report to the company, and inform them that they must carry out the requirements contained in such report and must submit plans showing the mode in which such requirements will be carried out, and to inform them that the low-tension service must be laid throughout the whole of the compulsory area and should be also laid in Huntriss-row. The Sanitary and Lighting Committee approved these recommendations, and now submitted them for the approval of the committee. The minutes were confirmed.

PROVISIONAL PATENTS, 1893.

March 27.

6439. **Improvements in electric switches.** Thomas Edmund Marsh and Thomas George Poole, 42, Reighton-road, Upper Clapton, London.

6446. **An apparatus for showing the phenomena of the expansion of crystals and other substances by heat produced by electric force.** James Swift, 81, Tottenham Court-road, London.

6468. **Improvements in electric arc lamps.** Siemens Brothers and Company, Limited, and John Nebel, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6470. **Improvements in electrical measuring instruments.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Arthur Edwin Kennelly, United States.)

6475. **Improvements in means and apparatus for varying the speed of electromotors or the electromotive force of electro-dynamos.** Joseph John Rickards, 47, Lincoln's-inn-fields, London.

6478. **Improvements in and relating to dynamo-electric machines and motors, and to circuits for use in connection therewith.** Elihu Thomson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

March 28.

6489. **Electric alarm in signal-boxes, whereby railway collisions may be avoided, with or without the aid of additional signals.** George Carrington Purvis, 43, Barclay-place, Edinburgh.

6517. **Induction system of electric heating and for other uses.** Samuel B. Jenkins, 77, Colmore-row, Birmingham. (Complete specification.)

6532. **Apparatus for recording excess currents in the working of electromotors for traction and other purposes.** Gisbert Kapp, 31, Parliament-street, Westminster.

6551. **A pyro-electric generator, an apparatus whereof such generator is an element, a process carried out by the aid of such apparatus, and a new compound gas made by such process.** Thurston Gordon Hall, 18, Buckingham-street, Strand, London. (Complete specification.)

6556. **Improvements in electrical instruments for medical purposes.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Boyd's Medico-Electrical Vitalizer Company, United States.) (Complete specification.)

6559. **Improvements in electric heating apparatus.** Mark Wesley Dewey, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6565. **An improvement in dry voltaic cells and in conducting connections for the carbons of these and other electric cells.** Siemens Brothers and Company, Limited, and Eugen Ferdinand August Obach, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6573. **Improvements relating to voltmeters.** Frederick Brown, 37, Chancery-lane, London. (Complete specification.)

6579. **Improvements in electrically-heated radiator.** Willis Mitchell, 35, Southampton-buildings, London. (Complete specification.)

March 29.

6605. **Improvements in diaphragms for use in electrolytic processes.** Ehwin Thorley Parker, Newbridge House, Tettenhall-road, Wolverhampton.

6613. **Improvements in street and like boxes for containing transformers used in electrical distribution.** The Honourable Charles Algernon Parsons and James Bonelle Willis, 13, Temple-street, Birmingham.

6627. **Improvements in the working of railway signals and points by electricity.** Illius Augustus Timmis, 2, Great George-street, Westminster, London.

6637. **Improvements in the application of electricity to closed carriages.** Frederick William Golby, 36, Chancery-lane, London. (Arthur Casella, jun., France.)

6649. **Improvements in telephone transmitters.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London.

6654. **An improvement in connection with electric bells and their contacts or current interruptors.** Edward Frederick Terrey, 177, Beresford-street, Camberwell, London.

6666 **Improvements in or relating to the distribution of electricity.** William Geipel, 49, Kidbrook-park-road, Blackheath, London.

6671. **Improvements relating to the electro-metallurgy of zinc.** Sherard Osborn Cowper-Coles, 45, Southampton-buildings, Chancery-lane, London.

March 30.

6677. **Improvements in railway electrical signalling devices.** Walter Grimes, 323, High Holborn, London.

6684. **Improvements in lighting and extinguishing attachments for electric and gas lamps.** Henry Leerhoff Müller and William Adkins, 6, Livery-street, Birmingham.

6697. **Improvements in the heating of gases by electricity.** William Donaldson, 33, South-street, South Kensington, London.

6702. **Improvements in dynamo brushes.** Karl Koch, 4, Corporation-street, Manchester. (Complete specification.)

6723. **Improvements in coatings or coverings for electric conductors.** Charles Thelismar Snedekor, 55, Chancery-lane, London.

6742. **Improvements in electric arc lamps.** Joseph Davenport Finney Andrews, 12, Batoum-gardens, London.

6751. **Improvements in the extraction of chromium by electrolysis.** Emile Placet and Joseph Bonnet, 6, Bream's-buildings, Chancery-lane, London.

6780. **Improvements in secondary batteries.** Velleroy Corney Doubleday, 77, Chancery-lane, London. (Max Sussmann, Germany.)

6785. **Improvements in or connected with apparatus for feeding carbons in electric arc lamps.** Frederick Hallows, 166, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1890.

16110. **Distributing electricity.** Parker and others. (Second edition.)

1892.

5988. **Distribution of electricity.** Raworth and Geipel.

6095. **Conductors for electric railways.** Belfield.

7016. **Incandescent electric lamps.** McFarlane and Edgar.

8108. **Making metallic articles by electro-deposition.** Davis and Evans.

8452. **Driving machines by electromotive power.** Chapman.

8638. **Electric mains.** Tomlinson.

10602. **Telephonic apparatus.** Myall. (Harrison.)

22914. **Printing telegraphs.** Wise. (Buckingham.)

22950. **Galvanic battery.** Haddan. (Gabarro.)

1893.

2145 **Dynamo-electric machines.** Lake. (Lundell and another.)

2494. **Telephone annunicators.** Whalley.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3 5/16
— Pref.	—	2 5/16
City of London	—	12¾
Electric Construction	10	4
Gatti's	—	5½
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4⅛
London Electric Supply	5	1½
Metropolitan Electric Supply	—	6½
National Telephone	5	5¼
St. James'	—	8
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Lecture.—Principal Garnett gave a lecture on "Some Pioneers of Electricity" on the 11th inst. at the Royal Victoria Hall, Waterloo Bridge-road.

Smoking Concert.—The second Old Students' smoking concert will be held on Friday, 21st inst., at 8 p.m., at Masons' Hall Tavern, Basinghall-street, E.C.

Electric Traction at Herstal.—The electric tramway which has been in course of construction for some time at Herstal, near Liège, will shortly be set in operation. The trolley system has been adopted.

Lamp Efficiency.—Mr. Swinburne, in *Industries*, wants manufacturers to return to the original way of marking so many "candles per watt," instead of marking the wastefulness of the lamps in "watts per candle."

Electricity Supply.—The Society of Arts, always to the fore with practical questions of electrical science, has arranged for a lecture on the 19th April by Mr. Gisbert Kapp on "Some Economic Points in Connection with Electricity Supply."

Paper Insulation.—At the recent Frankfort Exhibition Messrs. Siemens and Halske showed a cable with paper insulation, and which was tested at 10,000 volts. The firm is now manufacturing in the Vienna cable works lead-covered cables insulated with paper for lighting, telegraphic, and telephonic purposes.

Victoria Technical Institute, Madras. — This building, which is estimated to cost some four lakhs of rupees, is now three-fourths finished. It was designed by Mr. Irwin, C.I.E., and in its construction, even more than in the case of the Law Courts, the building will be carried out by local agency as far as possible.

Bohemian Concert.—The City of London Electric Lighting Company will hold a "Bohemian Concert" at the International Hall, Café Monico, for ladies and gentlemen (morning dress) under the patronage of the directors, on the 20th inst. The programme is most enticing, and commences at 7.30 p.m., with smoking after 9 o'clock.

Meteorology.—At the meeting of the Royal Meteorological Society on the 19th, papers will be read as follows: "Notes on Photographs of Lightning taken at Sydney Observatory, December 7th, 1892," by H. C. Russell, B.A., F.R.S.; and "Notes on Lightning Discharges in the Neighbourhood of Bristol, 1892," by Ernest H. Cook, D.Sc. The papers will be illustrated by lantern slides.

Telephone Patents.—The patent numbered 492,789, issued March 7th this year for a speaking telegraph or telephone, was applied for by Edison on September 5th, 1877, nearly 16 years ago. It has been held back "by concerted action between the Patent Office and Edison" until the present time. If the patent is held to be valid it may control the telephone industry for 33 years from date of filing.

Electric Pumps.—An electric pumping plant, with a capacity of 2,000,000 gallons per 24 hours, is to be started at the San Antonio Waterworks, Texas, by the Gould Manufacturing Company, of Senecca Falls, New York. Ultimately the pumping plant will be increased to 10,000,000 gallons daily capacity, and current will be generated at a point three miles distant, where water power is available.

Electric Cooking.—The electrical cooker, thinks *Kuhlows*, is yet in its infancy. From an economical point of view it will not bear comparison with the gas-stove. This will be a drawback to its general adoption amongst the middle and working classes. But a still more serious objection is the time that such a cooker takes to roast or to bake. Whether or no these two objections will be removed time alone will determine.

Maximum Electric Current.—Prof. W. J. Humphreys, professor of physics, Miller Manual Labour School of Albemarle, sends to the *Scientific American* of the 1st inst. a mathematical proof of the fact "often stated, but not proved," that the maximum electric current obtainable from a given number of cells, is got when they are so arranged that the internal resistance of the battery is equal to the external resistance of the circuit.

Engineer Apprentices.—The Government of India are of opinion that the period of six months' service as an apprentice is too short for the complete and proper training on works necessary to fit these officers for the duties of assistant engineer; and that the discretion left by the rule as it now stands to promote after that period is too freely used. Under these circumstances, the Government of India have decided that in future engineer apprentices shall not be promoted until after one year's training.

Indian Telegraphs.—Between the beginning of this year and the 1st of the present month a hundred new telegraph offices had been opened in India. A large proportion are in Lower Bengal and Madras, in both of which provinces the telegraphs pay better than in others, a result attributed to the facts that trade is brisker there than elsewhere, and that people are on the whole better educated and seem to understand more readily the great advantages afforded by the telegraph wire.

Speed-Limit of Trains.—Mr. Charles Steinmetz thinks the limit of high speed for trains is 220 miles an hour, this limit being that at which friction between rail and wheel is overcome and above which the wheels simply spin. There is a limit of course to this, and to the holding together of the wheels, but experiment has yet to prove where the limit lies. Long before we reach the limit of Mr. Steinmetz, a complete revolution in permanent road, in methods of signalling, and so forth will be required for a speed probably sufficient for the desires of the day.

Gilgit Telegraph Line.—There seems every prospect, according to the *Indian Engineer*, of a good working line of telegraph being established this summer between Srinagar and Gilgit. Before winter set in an experimental wire was laid from a point 12,000ft. high on the passes into Srinagar, a distance of 42 miles. Tests have shown that this has stood the trying ordeal of heavy snowfall and severe frost, the insulation being quite satisfactory. A second wire, it may be added, is being laid from Srinagar to Mari by the Indian Telegraph Department, which took over the Durbar line a few months ago.

Electrical Interests.—Mr. Herbert Laws Webb, who is now in England again, has made quite a technical literary reputation in America. Besides many articles in electrical and popular journals, he has just gained the 100dol. prize for the best article in the *World's Fair Electrical Engineering* on "How can the Department of Electricity in the Exposition best serve Electrical Interests." Not by direct returns, thinks Mr. Webb, nor in enabling men to place orders at once, but by cultivating the interest and attention of the general public, and he says this so succinctly and artistically that he is paid at the rate of some five pounds a page.

Chemical Training.—Prof. Armstrong, in the discussion on the paper by Sir Philip Magnus on "Technical Education" before the Society of Arts, said he had given much time and written several works upon the best means of establishing chemical laboratories for technical training, which had been embodied in the City Guilds Central Institution laboratory, but that although willing to help, he ha never been asked or consulted by anybody upon this im tant question of the proper teaching of chemistry to children and young men. The Germans were getting far ahead of England in this respect, both in private and public chemical laboratories.

Electric Horticulture.—Electricity is beginning to play an important part in horticulture. In a recent issue of *Amateur Gardening*, a correspondent records the following result of experiments in the "aero-electrification of soil" in which plants were grown: On January 10 he planted some hyacinth bulbs in pots specially constructed. The bulbs grew rapidly, and the plants came into bloom on February 14. Some Chinese lilies came into bloom five days later. Some lilies of the valley were planted on February 20, and started blooming on March 9. The temperature of the room in which these were grown was 56deg. to 60deg. F.

Rotary-Current Motors.—The General Electricity Company, of Berlin, have now succeeded in constructing large rotary-current motors having neither commutators nor friction rings or contacts. Among several recently despatched to the Chicago Exhibition was one of normally 50 h.p. At a test of this motor the total efficiency was found to be between 90 and 93 per cent., the consumption of current amounting to 280 amperes at a pressure of 100 volts between the two main leads. The number of revolutions of the eight-pole motor at full load was 725 per minute, when the number of alternations of 100 (50 full periods) was given. During a test extending over eight hours the motor only got heated to the extent of from 40deg. C. to 50deg. C. The motor weighs 24cwt.

Turbines.—Suppose a town authority or a private gentleman has a waterfall in their grounds, park, or at a distance, suitable for producing power for electric light. What power can be obtained, and how? Turbines, naturally, will be used; and if one wants practical information as to the use of turbines, the enquirer could not do much better than communicate with the author of a pamphlet on the "Victor Turbine," Mr. F. Nell, of Mark-lane, whose illustrated book is full of most interesting details on the utilisation of water power. Plans are given with sizes of the turbine installation, with illustrations of turbines—vertical, horizontal, and coupled. The turbines are shown as driving dynamos both direct or with belts, and for high and low falls. There are some 60 illustrations, and the pamphlet also contains directions for fixing and running, measurement of water power, tables of weirs, and tables of high heads of water.

Electricity at Theatres.—A curious conflict has arisen, says our Paris correspondent, between the Popp Compagnie and the director of the Grand Theatre, M. Porel. The Popp Company has installed below the hall of the Grand Theatre an electric station of 400 h.p., driven by compressed air. The regulations of the Theatre Commission do not allow a theatre to be established directly over works. The commission has therefore notified M. Porel to remove the machinery or close his theatre. As the works and machinery belong to the Popp Company, M. Porel is not able to close the generating station. He can only call upon the Popp Company to place their station elsewhere. No result has followed this notice, and the director has had to close the theatre. Some curious lawsuits are likely to arise. The building in which is the theatre was let separately, without special clauses, and the basement to the company, and the rest to M. Porel, so that the dispute is now between the landlord and the director of the theatre.

Accumulator Sub-Stations.—The *Journal* of the Institution gives the following abstract of a paper by *Hermann Müller in Elektrotechnische Zeitschrift*, Vol. 13, No. 28: "The author considers that in sub-stations of this kind three points should be observed: that each cell should be perfectly accessible; but therefore the arrangement must be systematic; and, lastly, that the ventilation should be perfect, and any instruments or apparatus thoroughly cut off from the cell-sheds. He proceeds to describe a station in Düsseldorf—one of three—which is to contain two batteries of 140 double cells arranged on a three-wire system, of which one is now installed, having an output of 500 amperes. The batteries are arranged in the usual manner—to be capable of charging and discharging in parallel. The maximum pressure being 2·6 volts per cell, the discharge switches have to be capable of cutting out 28 cells, in order to keep the supply at 110 volts during maximum charge. These sets of 28 cells are arranged over one another, in order to have the copper connections of simple character."

Mechanical Engineers.—At the meeting of the Institution of Mechanical Engineers on the 20th and 21st inst., papers will be read as follows: "Second Report to the Alloys Research Committee," by Prof. W. C. Roberts-Austen, C.B., F.R.S. The report will deal with: Possibility that mechanical properties of a metal will be influenced by small quantities of added elements in proportion to their atomic volumes: thermal capacity, elasticity, rigidity, cohesion; molecular porosity, in relation to atomic volume; influence of impurities on copper; tensile tests of copper rods; mode of casting pure electrolytic copper in thin rods, free from oxidation; working of experimental copper rods; effects of arsenic, of bismuth, and of antimony on copper; curves showing influence on tenacity of copper; series of copper-bismuth alloys; cooling under pressure; improved autographic recording pyrometer. "Tensile Tests and Chemical Analyses of Copper Plates from Fire-boxes of Locomotives on the Great Western Railway," by Mr. William Dean, locomotive superintendent, dealing with tabulated details of copper fire-box plates; mileages; tensile tests: breaking stress, contraction of area, elongation; testing-machine, and test-pieces; chemical analyses.

Electric Tempering.—In recounting the results of some experiments in electrolysis before the Academie Royale de Belgique some time ago (says a note in the *Iron and Coal Trades Review*), Prof. Lagrange and M. Paul Hoho drew attention to the luminous sheath which surrounds a fine wire when used as negative electrode in an electrolytic vessel through which a powerful current is passing. Pursuing their investigation, the same gentlemen have now discovered that the sheath is not only luminous, but intensely hot, the heat being local. A piece of iron 10 centimetres long and one centimetre in diameter can be heated, by proper arrangement of non-conducting screens, in alternate sections, each one centimetre in length, the heated sections fusing while the cool sections are still quite cold. So rapid is this heating action that a rod of iron can be made white hot at the surface before the interior is affected, so that by suddenly making and breaking a circuit the surface of a piece of iron is suddenly heated up and then quenched in the electrolyte, thus getting an exceedingly hard coating, the depth of which depends on the duration of the process. Samples of iron treated in this way exhibit totally different fractures at the surface and in the interior. Electrical heating for tempering has been in use for some years, but this process seems to permit the quenching of very fine springs, and promises to be useful in case-hardening.

Technical Training at Sheffield.—At a recent meeting of the Society of Arts a paper on "Technical Education: Its Progress and Prospects," was read by Sir Philip Magnus. In the course of a discussion following the paper Mr. R. A. Hadfield said that in Sheffield they were carrying out technical education on special lines somewhat approaching those indicated in the paper. Sheffield, in fact, was the first borough to take advantage of the Technical Instruction Act. In the last three years they had spent something like £14,000, and starting with 90 students they had now 191 day and 490 evening students. From the school had sprung a society of engineers, a society of metallurgists, and several others. The teaching was practical as well as scientific; he certainly thought the practical side ought not to be lost sight of. The students were taught to make the crucibles to melt the steel, cast it, forge it, and turn it into finished tools. They had also an open-hearth furnace which would melt nearly 1·25 tons, and they also carried out foundry work. In consequence of the work done at the technical school much greater interest was taken in the city in all scientific matters. Owing to the rapidly increasing complexity of modern improvements, as shown in electric lighting and telephonic engineering, such schools were becoming a necessity, but it was necessary to take great care that they were properly and efficiently carried out.

Relation of Candle-Power, Voltage, and Watts. M. Carl Hering in his notes translates and condenses an article by Messrs. Feldmann and Versteeg, in the *Elektrotechnische Zeitschrift*, February 3. Very extended data are given from the results of tests made with incandescent lamps at very greatly differing voltages. One set of lamps was tested at 37 different voltages, from 21 to 176 volts, the details of which are given in a table. The paper also contains curves giving the observed and the calculated candle-power at different voltages, the amperes, the watts, and the watts per candle, all as functions of the voltage. Another curve shows the variation in the resistance. Another gives the candle-power as a function of the voltage, first for increasing voltages and then for decreasing voltages, which are, however, of less interest. For the Zurich lamps they deduced the following formulæ:

$$\text{Candle-power} = 2{\cdot}64 \times 10^{-13}\,(\text{volts})^{6{\cdot}8};$$

$$\text{Candle-power} = 6{\cdot}56 \times 10^{-5}\,(\text{watts})^{3};$$

$$\text{Watts per candle} = \frac{4{\cdot}88 \times 10^{9}}{(\text{volts})^{4{\cdot}8}}.$$

Similar formulæ were found for quite a number of other lamps, all of which are given in that paper; the formulæ for the watts all contain the watts in the third power, but the constant in the equations as well as the exponents for the voltage differ quite materially from each other, so much so that a mean would have very little value.

Foreign Patents Worked in France.—In the course of an article on electricity and the national industry in France, in the *Electricien*, M. Ch. Haubtmann states that they have always been opposed to protective customs tariffs, which they consider as most injurious to the development of the French manufacturing industry. Foreign competition, he says, if it causes daily anxiety to manufacturers, has at least the advantage of constantly keeping on watch the spirit of progress and improvement. With the growth of electrical applications, the large French works have become tributaries of German firms, and they distribute in France German plant which the French Legislature had believed to have stopped at the frontier by its protective tariffs. As instances of this the four largest engineering works in France are mentioned—namely, the Creusot, the Compagnie de Fives-Lille, the Etablissements Cail, and the Société Alsacienne de Constructions Mécaniques. Each of these concerns has followed the general course of affairs. The Creusot owns the French patents of Zipernowski, Déri, and Bláthy, and solely manufactures the electrical plant of Messrs. Ganz and Co., of Budapest. The Compagnie de Fives-Lille, who has recently decided to undertake electrical work, has just obtained the monopoly of working in France the patents of the General Electricity Company, of Berlin. The Etablissements Cail have taken up the manufacture of the Berthoud Borel cables, and the Société Alsacienne de Constructions Mécaniques are working the patents of Messrs. Siemens and Halske, of Berlin. M. Haubtmann deplores the adoption and pursuance of this policy to the detriment of purely French inventions. He concludes that without protective tariffs the patents for German manufactures, entering France free, would not have been taken up by the large French engineering works, and that the competition which would have resulted through the free entry of German manufactures would have induced the French works to push forward in the van of progress, and cope with the German firms.

The Tivoli Station.—The following abstract is given in the *Journal* of the Institution from *Elektrotechnische Zeitschrift*, 1892, No. 37: "This is a transmission which exhibits several features of interest. The well-known waterfalls of Tivoli supply the power, the amount of water passing being about 40 cubic feet per second, and the fall altogether about 330ft. The main channel feeds three pipes, from each of which three channels lead to as many turbines of the Girard type. Each group of three machines consists of two 330-h.p. turbines and one of 50 h.p., which are coupled directly to the corresponding dynamos, and which run at 170 and 375 revolutions per minute respectively, being governed by automatic regulators on the Ganz system, which are said, by controlling the amount of water supplied, to regulate quite as well as the best steam-engine. All this apparatus is underground, and every precaution is taken to keep the machine-room dry. The dynamos coupled to the larger turbines are alternators giving 42 amperes at 5,100 volts, and having wheel-shaped field magnets about 7ft. in diameter, and having 30 poles. The smaller turbines run the exciters, four-pole machines giving 180 volts and 150 amperes, and each capable of exciting three alternators. Both alternators and exciters are run in parallel, an artificial load being provided to run the machines up to speed upon. Automatic regulators of the Bláthy type keep the pressure in Rome constant by altering the excitation of the direct-current machines. The switching arrangements are as usual, but the switches are of unusual type, consisting of ebonite pots containing mercury, into which contact-rods are plunged by raising or lowering the pot. The distance of transmission at high tension is 26 kilometres, or about 17 miles, bridged by four conductors run on oil insulators, three of which are capable of carrying full load. These end in a transformer station near the Porta Pia, just outside the walls of Rome, where the pressure is about 4,000 volts (as there is 20 per cent. drop at full load), and where it is lowered by two groups of 16 transformers to 2,000 volts, and fed into the cable network in Rome. There are also transformers feeding the 250 arc lamps now installed, and capable of supplying 600. These have special windings to allow of various numbers of lamps being run in series. The whole system of distribution is that of Zipernowski-Déri-Bláthy, and carried out by Ganz and Co., of Budapest."

Electric Furnace.—MM. H. Moissan and J. Violle (in *Comptes Rendus*) give the details of their electric furnace. The furnace is composed essentially of a hollow block of carbon, inside which the arc plays between two horizontal electrodes. This block is in the form of a cylinder whose height is equal to its diameter. It is formed by a piece of carbon tube standing on a plate of the same substance, with another disc of carbon on the top as lid. Two slots allow electrodes to pass through. The cylinder is placed inside a block of chalk similar to that employed by Deville and Debray in the fusion of platinum. The cylinder does not quite touch the chalk walls, but is separated by a layer of air 5mm. thick, and its base rests on blocks of magnesia. The dimensions depend on the power at disposal. For currents between 300 and 500 amperes the internal cylinder is a tube of 5cm. (2in.) diameter. The electrodes are 3cm. to 3·5cm. diameter (1⅛in. to 1¼in.), and the block of stone is about 20cm. high, 2·5cm. wide, and 30cm. long (7½in. by 1in. by 11in.). The lid of the same cross-section is 4cm. to 5cm. (1¾in.) thick. The cylinders, of carbon, which are used as electrodes are carried by iron contacts mounted on sliding supports, so that they can be approached or drawn apart with ease. They receive the current through stout copper sleeves, fitted with jaws, between which the conducting cables from the dynamo are fixed. This arrangement, suggested by M. Tresca, is very convenient for striking and using the arc. The two models are constructed under the following conditions. The first is suitable for fusion of refractory metals, such as chromium and manganese; it contains, at the bottom of the cylinder, a crucible of carbon made either in agglomerate or retort carbon, which holds the mixture to be reduced. The second type is constructed for calorimetric researches to determine the temperature of the arc. The bottom of the inner vessel is formed of a movable plate acting like a drawer. To the positive pole is a fragment of carbon, sustained by a rod of the same substance sliding with gentle friction in a tube of carbon. By a slight movement the fragment transformed into graphite is dropped into the calorimeter at the temperature desired. The temperatures obtained varied according to the duration of the experiment and the size of the furnace. There is no limit save that of the electric arc itself. The more the field of heating is restricted the nearer we approach the temperature indicated by one of the authors, as that of the arc (3,500deg. C.). Practically, it is fairly easy to obtain with such apparatus the temperature of 3,000deg. C. Illustrations of the furnace are given in the *Comptes Rendus*, and in *Cosmos* for April 1.

Brillie Central-Station Meters.—A meter on the Brillié system for 800,000 watts has been recently constructed for the Société Norman de l'Electricité for use at their new station at Rouen. This meter is designed to work on a three-wire system, measuring up to 8,000 amperes at 100 volts. We fancy this must be the largest continuous-current meter constructed up to the present. The largest Brillié meter hitherto made was one for the Société des Métaux, at Paris, for 200,000 watts. The Rouen meter is fitted with an automatic recording arrangement, giving the curve of the watts passing in the instrument at any instant. This recorder is formed, in principle, of a cinemograph of special type, whose horizontal plate is moved at a constant speed by means of a small electric motor, which also drives the drum carrying the paper. This drum makes one turn once every 24 hours. The needle of the cinemograph is driven by the train of the electric meter. When no current is passing, the needle rests at the centre of the horizontal plate, at zero; but when the current passes through the meter and this begins to measure, the needle is shifted an amount corresponding to the number of watts and traces the curve. This cinemograph is based on the same principles as the meter itself (see vol. ix., page 586, and vol. x., page 341), and is consequently completely independent of the variations of friction. The instrument is ingenious in design, and is likely to render good service in central stations. A meter of this type, but smaller, for 50 amperes, is working at the Kensington and Knightsbridge Company. We understand that the Compagnie Anonyme Continentale, who are constructors of the Brillié meter, have now completely modified the form of the practical instrument, while preserving the principle. Their new type is not yet fully patented, but we hope shortly to be able to describe it. It possesses—besides the advantages of the present type, in exactitude, sensibility, small consumption of current, sureness of starting, accurate proportionality—also the immense advantage of being very simple in construction. The old type of Brillié meter was certainly somewhat complicated. The later model, we are told, has all the other advantages, and is, moreover, of extreme simplicity; it is of light weight, small size, strong, and of quite low price. We shall be interested to see the new meter in work, as it would seem to combine the requirements both of the Board of Trade and of the companies. The designers of the new meter have taken the gas-meter as their model, and sought to obtain in an electric meter, together with greater correctness of measurement, the same qualities that exist for the gas-meters, of strength, simplicity, and low cost, while using the principle of the Brillié meter, in which the registering gearing is not influenced by variations of friction of the moving parts.

Electricity in Italy.—When we begin to invent a machine the first models are heavy: afterwards economy of material is obtained. For instance, Dr. Albert Battandier, in *Cosmos*, gives, for 1881, the weight of 210 kilos (4cwt.) per horse-power as that required in building a dynamo. In 1889 this was reduced to 52 kilos (1cwt.), and 21 kilos (46lb.) in 1891—that is, in 10 years we have reduced the weight 90 per cent. Machines of only 18 kilos (40lb.) per horse-power are now being built. This progress shows that electric light is the light of the future for countries like Italy having abundance of water power. The water of the Po, for instance, with a fall of 100 metres and a mean flow of 1,720 cubic metres per second, gives 2,300,000 h.p., or six times the total horse-power of all the Italian locomotives at present in use. Another simple calculation shows that dividing this power by the size of the Po watershed (74,800 square kilometres), we have a force of 30 h.p. per square kilometre. The province of Milan, 3,100 square kilometres, might use 93,000 h.p. Now, Milan only uses 11,700 h.p., of which only 775 are obtained from water power. The other 11,000 h.p. represents a force coming from abroad in the shape of coal, and which must be paid for in gold. Loss may occur in transmitting electricity, but the Lauffen-Frankfort transmission showed an efficiency of 74 per cent., or a loss of 26 per cent., comprised thus: 8 per cent. in dynamos, 11 per cent. in line, 7 per cent. in the double transformation. If, therefore, a society of capitalists wished to transmit the power of the Po to Milan, the loss on the line being but 2 per cent., they could utilise 83 per cent. of the horse-power of the water. These ideas are gaining ground in Itly. Turin, and almost all the towns of Lombardy and Piedmont, are splendidly situated for utilising Alpine torrents, and when business men have learned to join together they will obtain returns not limited to themselves, but spreading far and wide. At Milan, for instance, when the Edison Company started, the first result was the lowering of gas 40 per cent.! But the Edison Company uses coal, and this expense prevents a further reduction in price of lighting. The company will shortly take, near Paderno, on the Adda, at 65 kilometres distance (40 miles), 7,600 h.p. and transmit it to Milan for lighting and motive power. The competition of gas will be squashed, as the latter cannot do without coal. The installation at Rome with power derived from the Tivoli falls may also be mentioned. The Italians are also studying the question of electric traction for carriages. Count Carli has built electric bicycles of various kinds, with reversible motor used as brake; springs are also added for easy starting to prevent overheating of the armature. The cost price is yet high, 1,800f. for storage cycles of two-thirds horse-power; 3,000f. (£120) for six-wheeled machine of 2½ h.p. In this 500f. is for the motor, 200f. for cells, and 800f. for machine. When these machines are cheaper many will doubtless be sold.

Single-Phase Alternator for Motors.—In an article by Elias E. Ries and Gordon J. Scott in the *Electrical World*, as follows, the authors say that in view of the discussion that has recently taken place in reference to alternating-current motors they desire to announce that for the last year and a half they have given a great deal of attention to the question of power transmission by the use of the commercial alternating circuits now in use. Experiments have been made on circuits the frequency of which varied all the way from 200 to 40 cycles per second. Some very interesting and useful facts have come to light, and the experiments have shown that practical alternating-current motors of any size can be built and operated at the ordinary frequency of 138 cycles per second, or even at higher frequencies, with a commercial efficiency equal to any direct-current motor. This has been fully demonstrated by experiments made upon a motor in the factory of the Ries Electric Speciality Company, which developes nearly 2 h.p. at the slow speed of 360 revolutions per minute. The total weight of this motor is just 64lb.; there are only 2lb. of copper on the machine, and it shows a commercial efficiency of 85 per cent. when run upon an ordinary incandescent lighting circuit of 50 volts at a frequency of 138 cycles per second. The motor referred to is built upon entirely new lines and is radically different from any of the types of alternating motors so far described. The motor operates without the use of condensers, reaction devices, secondary batteries, or similar paraphernalia for changing the lag or phase. In addition to this type an entirely new and novel single-phase motor of high efficiency will be built, having a completely closed magnetic circuit, and, as a consequence, a very small magnetising force. For electric railway work there is a special form of this motor under way, which will have a variable speed with a maximum torque—a feature that has not heretofore been possible, either with direct or alternating-current motors, although numerous attempts have been made by various well-known inventors to produce this desirable result in direct-current practice by the use of motor-generators, differential gearing, and other equally complicated devices. The Ries and Scott railway motor of this type will be of 20 h.p., and will weigh, when completed, about 600lb., which is less than one-half the weight of direct-current railway motors, thus combining great starting effort with low consumption of energy and with very light weight. Owing to patents pending, no details are given, but the authors state that in a few months a reliable and self-starting synchronous or non-synchronous alternating-current motor will be obtainable, fully equal, if not superior, to any direct-current motor that has been built. This motor will not only solve the difficulty that has thus far been encountered in utilising single-phase alternating currents for operating stationary motors of all powers, but will also render it commercially possible to employ the alternating current for electric railway work on a scale that will render the system for economy in transmission and regulation, to say nothing of the increased safety and freedom from repairs, far superior to the direct-current electric railway practice of to-day.

State Telephone to Ireland. — The telephonic communication between the Post Offices of Glasgow and Belfast has been established, and in this we have the first instalment of the Government telephone system which was authorised last year by Parliament. It was in March last year that Sir James Fergusson, then Postmaster-General, formulated a scheme whereby the Government should have possession of the trunk wires in connection with the telephone system of the country. When the Post Office originally granted licenses to telephone companies, these licenses were restricted at first, but were afterwards made universal. In fact, 13 companies were granted powers extending over the whole kingdom. It was intended by those means that the public should be efficiently served by the competitive efforts of the companies. These companies, however, nearly all amalgamated and became absorbed in one large company—the National Telephone Company. Owing to the failure of the intentions of the Government, however, the telephone system had made less progress in this country than perhaps in any other country in Europe, partly due, doubtless, to the restrictions imposed by the Post Office licenses, such as the prohibition of delivering messages and the want of communication with the Post Office, except under considerable charges. The aim of the Postmaster-General was to devise a system which would facilitate instead of restrict the telephone industry and, at the same time, safeguard the Post Office telegraph system. The two systems should work in alliance, but as the telephone would in a great measure replace the telegraph, it was necessary the Government should at least own the trunk lines. The Government did not wish to interfere with the commercial business of the companies in establishing exchanges as widely as possible wherever their enterprise might lead them; they merely wished to control the junction of these exchanges. The new wire from Scotland to Ireland is 145 miles in length, and, with the exception of half a mile below the streets of Glasgow and 22 miles below the Irish Channel, it is entirely overhead. It starts at the Post Office in George-square and extends to Port-Patrick, where it enters the Irish Channel. It emerges from the sea at Donaghadee, and extends to Belfast. The land conductor is a solid copper wire weighing 800lb. to the mile, and the sea conductor is in a cable insulated with guttapercha, and lined with brass ribbon to protect it from the ravages of that cable destructor—the teredo. The cable, which weighs about 13 tons to the knot, contains four conductors, each 180lb. to the mile. The four conductors form two circuits. The telephone will not be at the service of the public for a short time until the necessary tests have been fully made. The arrangements are most complete. Two well-appointed cabins have been erected in the telegraph department of the Post Office for the use of subscribers, and these are connected with a switch-room upstairs. Simultaneously with the operator taking his seat the enclosure is automatically lit up by electricity and the connection made with the switch-room. The instruments used are an improvement on the Gower-Bell system, designed by the Post Office officials. The Gower-Bell transmitter has been retained, but in place of the old receiver with its indiarubber hearing tubes, two of the latest form of Bell receivers have been substituted. The switch-room has also been fitted with switchboards for the reception of other trunk wires, which are in course of erection, and for private wires for local subscribers. The experiments which are being made with the wire are entirely satisfactory, speech being quite distinct, and the line promises to be of the greatest utility between the two countries. The Post Office officials are to be congratulated on the zeal and energy with which they are pushing the use of submarine telephones around the United Kingdom.

THE TRAINING OF ELECTRICAL ENGINEERS.—II.

The objections often hurled at the science colleges by practical men are only partly justifiable, for the practical man is sometimes oblivious of the other side of the question. The professors urge, and rightly, that something beyond the actual workaday applications has to be taught—theory, principles, the power of thinking and reasoning and of mastering problems in their purely scientific aspect, apart from money-grubbing practice. This is true—and we must be careful to distinguish the two aspects of education. The two, however, exist; and if practical men sometimes forget the professor's point of view, the professor often forgets that of the practical man: indeed not unfrequently he is hardly aware of it, or does not accord it full importance. In such technical handbooks as that of Prof. Thompson, it has to be pointed out that two or three of the most important points in the design of machines have been but slightly touched upon or not at all. For instance, the calculations of the loss of power by Foucault currents in moving conductors—this has to be taken into account and calculated by the designers of large electrical machinery; the calculations for accurately compounding a compound dynamo — most necessary in machines of the present day; the calculations that shall enable an engineer to build an armature to run to any specified temperature above the air. These are some of the practical problems not yet fully dealt with that come before the electrical engineer. But in very many points, as we have said, the City Guilds' classes have shown, under their able professors, how the practical problems of engineering may be combined with, and illustrated by, theory, and how real training in electrical work may proceed hand-in-hand with the study of the more abstruse problems and the higher calculations and measurements that science demands. We are urging for a still greater measure of this accord of practical and theoretical throughout the whole training of electrical engineers.

Three sets of men are occupied with this question of technical education—the students, the professors, and the engineers. The highest efficiency of the colleges will be obtained when all are satisfied to the highest point possible. The students want knowledge, useful training, and means of obtaining good positions; the practical men want assistants properly taught and trained; the professors are trying to satisfy these requirements and at the same time fulfil certain other duties which they owe to science and to reason—in the thorough teaching of scientific principles, the training in logical habits of thought and work, and the cultivation of nobler aspirations towards the investigation of Nature's laws.

The students will be misled in their hopes and rightful expectations if, at the end of their training, the engineers say to them: You are almost useless to us—you must begin again and learn something useful; you have been learning matters we do not want you to know, and you have not learnt matters that we do require you to know. The teachers, therefore, would be wrong not to listen to the desires of the workaday engineering world, and refuse or neglect to ask of the practical men what it is that they require in their assistants. They have not done so often enough in the past history of so-called technical training, but they are doing so more and more.

They would, however, be equally wrong if they did nothing but teach such knowledge as is immediately applicable. The school or college is, perhaps, the only place where true ideas of principles can be patiently taught, and far be it from us to insist that the colleges should occupy themselves only with practical needs of commercial men. "Some students," says a learned correspondent on the subject, "learn very slowly even the most general principles." Truly, such is often the case. But is this the fault of student or of professor? Perhaps there is a "science of teaching principles" that is as yet only dimly and unconsciously perceived even by teachers and professors; and this science or process of teaching principles is, we are sure, related very strongly to the question before us—the giving of useful applicable training in actual work. Principles and *theories can only be grasped* when based upon the concrete realities that they spring from, taken in with an extended view by the mind surveying the realities and comparing them together—analysing or combining the essential properties in their various forms or states, *as existent in actual realities.*

Now, what concrete realities should be taken to argue and reason upon? Should these be imaginary, hypothetical, useless antiquated matters—or not rather those real, practical, useful up-to-date realities which are just those which are met with in everyday engineering practice? Evidently, if the latter are taken, *consciously*, *always*, and *of fixed purpose*, the student will have learned these, and then be quite capable of reasoning upon them. Abstractions, theories, and principles are quite beyond the grasp of any beginner, until the realities from which they are abstracted are present to the learner's as to the teacher's mind; and it would be far better that these realities should, as far as possible, be just those which the engineer requires. What are these realities? That is the question we ask of the engineers; that is the question we would urge the teachers continually year after year to ask of the engineers. Too often the teaching, admirable in its way, is based upon practice almost antediluvian in character, and, therefore, the pupil, though theoretically well trained, is, in the words of a previous correspondent, "mostly useless."

It is urged that commercial training cannot be given in schools or colleges. This is true. Our contention is not that it is not thoroughly given, but that it is not given at all—not even so much as hinted at in all the three years' course for many classes. Pupils often leave the training college not knowing what materials are used for the various parts of machinery, nor why these materials are used. They know nothing of the comparative prices of wrought or cast iron and other materials, nor what makes one dearer than the other. They often have no conception of the relative value of material and labour in the machine or installation, nor what steps should be taken to modify design or calculations from such factors of the calculation. It is too much to expect professors to teach engineers the whole of the commercial part of engineering. But is it too much that they should touch upon it when it modifies design, or give the students some true perspective of the conditions of actual work in which they will be placed when they leave college classes for work?

Prof. Alex. B. W. Kennedy, F.R.S., writes to us: "The questions raised are so important that they cannot be answered in a few minutes, and I really have not the time at present to spare to deal with them as I should like to do. I am one of those who hold very firmly to the idea that an electrical engineer must be first made a thorough-going mechanical engineer, and that mere electrical knowledge, however complete, without all the training that a mechanical engineer ought to have, is of little use for the actual work which the electrical engineer has to do."

The following letter is from Mr. E. Eugène-Brown, electrical engineer and dynamo designer to Messrs. Holmes, of Newcastle:

"The question of technical training has given me much thought. I do not think that real training for the hands can be given in improvised workshops; most of the work done there is meaningless, and real practical and economical methods are seldom used.

"As to workmen, we find that joiners and plumbers or bellhangers make the best wire-runners; the joiners soon learn jointing, then there is little more to learn, as they are directed by the chargeman. This chargeman is mostly an intelligent workman raised to the post, who understands the running of dynamos and engines, the erection on their foundations, the coupling-up of steam-pipes, etc., so that preferably he would have commenced as a fitter. As to theoretical knowledge, they must have picked it up as they went along. They get to know by *practical application* what volts, amperes, and ohms mean, and the signification of Ohm's law.

"My idea of what an assistant electrical engineer should be is this. He should be trained as a mechanical engineer either in a mechanical engineer's works, or in the fitting shops of a large firm of dynamo-makers where steam-engines are constantly tested. He should have been for a certain time in the electrical testing-room and drawing office. In the latter place he would be able to apply the knowledge gained in the shops, and 'concrete it,' so to speak. If he has used his time seriously for three or four years thus, and has been working on several installations, I should consider him qualified for the post. He would have been well advised to have attended, in the evenings, the theoretical classes at any college; but if he really enquired into the meaning of all he saw from the heads of the departments, or gathered from his own private reading, he must of necessity have gained theoretical knowledge.

"Of course there are many who have no chance of passing through all this; and are apprenticed to some firm who only instal but do not manufacture. These are at a decided disadvantage, and their progress is more difficult.

"Thus, the first qualification of an electrical engineer is that he should be first a mechanical engineer. If he has passed through the works as a fitter—given a good previous education with elementary mathematics and mechanics—he can soon learn all that is necessary about electricity. So I always advise the youths to learn mathematics and mechanics, making light of the technics of electricity, as easily acquired if they have time. Physics and chemistry are not only useful but absolutely necessary to the really competent electrical engineer. But the cramming for Science and Art certificates is but little use—to get real knowledge they must see its practical applications.

"The day technical schools are a delusion and a snare; the evening classes are really and thoroughly useful to those engaged in practical work during the day.

"Since writing the above (except the last paragraph), I have read your article and agree, as you will see, with Mr. Esson. As I get all our apprentices into my hands ultimately, as the drawing office is their last term of service, I get to know what they have learnt, and can pick out the dull and idle ones. They get summed up, so to speak, in my office."

With regard to the exact questions demanded when engaging an assistant engineer or workman, Mr. Eugène-Brown says that it is naturally difficult to state the exact questions that would be given: "There are so many branches that one never expects anyone in a subordinate position to know too much. The drawing office is a most important part of every works, and the assistants there need not necessarily be electricians. All the designing is done there, and draughtsmen trained as mechanical engineers are preferred. The first question we should ask a candidate for a post of assistant electrical engineer would be: 'Where have you served your time?' and we should judge in some measure by the standing of such place; then, 'What particular work were you most engaged on during your apprenticeship?' 'What work have you been engaged on since?' 'Have you had charge of any large installation, and on what system?' The extent of his experience would guide us, and we should never think of asking him if he had studied any particular book, or if he had any Science and Art certificates. I can imagine a small firm wanting a man to know many things, but things are usually so divided that, speaking of our own experience, we choose the man for the particular kind of work. Thus, to an outside assistant engineer, we should say: 'Have you ever carried out entirely under your own supervision an installation to a definite specification, planned and supervised the wiring and fittings, the laying of the foundations, the lining-up of the engine and dynamo, erection of boiler and steam-pipes, and set the installation to work, from plans supplied from the drawing office?' To a workman: 'Where did you serve your time?' 'What sort of work are you used to?' 'What firms have you worked under?' It resolves itself all into a matter of *experience*, its *duration*, and *variety*. When wiring a place, we always send a variety of men—a wire-runner, a joiner, a fitter—as occasion requires, never depending on one man knowing all."

We have received the schedule of the "employment register" of the City Guilds Institute Old Students' Association from Mr. Reginald Wallis-Jones. The details to be filled in are as follows: (1) Name and address; date of birth. (2) Technical training—certificates and other awards, if any. (3) Practical experience—state kind of work mostly accustomed to. (4) Commercial experience; languages (*a*) can speak, (*b*) can correspond in. (5) Remarks as to any special qualifications. (6) What at present engaged in?

Mr. Reginald J. Wallis-Jones writes: "In my opinion the maximum advantage is derived from a course of technical training, when it is combined with and taken concurrently with the older system of apprenticeship. Undoubtedly one of the greatest advantages of the latter is the largeness of the time factor, which allows of proper assimilation of knowledge—a state of things impossible under modern systems of cramming. The difference in value to an employer between a man who has only a practical (or rule-of-thumb knowledge of his work) and one who combines with practice a theoretical knowledge, is enormous. The former is limited to the kind of work of which he has had actual previous experience, and new features or difficulties cannot be tackled in an intelligent manner; while the latter is always ready to appreciate new conditions of work. It would seem to me that much remains to be done in preventing the waste of energy which is so common in trying to train men for work which they are naturally unsuited for. Surely some means of test or examination can be arrived at at the end of a given period of probation whereby the natural bent or talent of the student could be discovered; after which special and not general training would be of the greatest use to him in his career. For after all, with few exceptions, the object sought for in technical education is to enable the student to attain the maximum success in his profession or vocation, and few of us (as Dr. Fleming tersely puts it) enter the professional race 'for the sake of our health.'

"In conclusion, I would point out that students should from the first day be brought face to face with the ever-present difficulty of producing the best results with the least cost (and generally within certain time-limits), for by financial results the average man stands or falls in after-life."

THE COST OF STEAM POWER.

In view of the great importance to electrical engineers of any possible reduction in the cost of motive power for the generation of electric energy, it is highly advisable to gather details and figures from actual experience to show not only what has been, and is being, done, but also by inference what can be effected in the future by way of little economies and savings here and there to reduce the cost of using power. Dividends, it is said, are often either made or lost between the coalpile and the dynamo belt: and the cost of fuel per unit of electrical energy is quite as important an item as the amount paid in salaries and wages. The following abstract of a paper read by Mr. Chas. E. Emery, Ph.D., before the American Institute of Electrical Engineers, New York, on the 21st ult., will therefore be read with interest, whilst some amount of useful information may be obtained from the tables accompanying the paper. The latter have, however, been slightly recast and altered so as to be more easy of reference, the values also being reduced to shillings instead of dollars:

A previous paper on this subject, read in 1883, is still, says Mr. Emery, substantially correct, but prices have changed. The present paper compares the cost of a unit of 500 net horse-power from several representative types of engines. The speed has been assumed in all cases to be delivered at 250 to 350 revolutions of high-speed engines and jack-shaft speed of slow engines.

Expenses independent of coal are fairly constant, independent of the type of engine, and without considering interest or dividends, will in some cases equal the cost of coal. Comparing two economical engines, one effecting a saving of coal compared to the other of, say, 12½ per cent., makes the relative costs of fuel as 8 to 7, but if additional costs equal to the former be added to both, the relative economies will be 16 to 15, and the saving reduced to 6¼ per cent. simply by the summation of costs. If all expenditures should pay 10 per cent. dividends on capital invested, and 10 per cent. of the difference in first cost of

TABLE I.—Details of Steam-engines Considered.

a.	b.	c.	d.	f.	g.	h.	i.	k.
Designation.	Type of engine.	Indicated horse-power to produce 500 h.p. net on engine shaft.	Steam pressure by gauge.	Feed-water per indicated horse-power per hour. Assumed.	Commercial horse-power of boilers. One C.H.P. equals evaporation 30lb. water at 70lb. pressure from temperature 100deg.	Water evaporated per pound of coal.	Coal per indicated horse-power per hour.	Tons of coal (2,240lb.) per day with coal for 1 hour added for starting and stopping fires. 20 working hours per day.
	Name.	i.h.p.	lb. per sq. in.	lb.	c.h.p.	lb.	lb.	tons.
A.	Simple, high-speed, non-condensing	542	100 to 120	33	596	8·5	3·882	19·725
B.	,, low ,, ,, ,, ...	556	100 to 120	29	537	8·5	3·412	17·785
C.	Compound, high-speed, non-condensing	542	100 to 120	26	470	8·5	3·059	15·544
D.	Special triple-compound high-speed non-condensing	542	150 to 170	24	434	8·5	2·824	14·349
E.	Simple high-speed condensing	542	100 to 120	22	397	8·5	2·588	13·150
F.	low ,, ,, ,, ...	556	100 to 120	20	371	8·5	2·353	12·265
G.	Compound high-speed condensing........................	542	100 to 120	20	361	8 5	2·353	11·956
H.	,, low ,, ,, ...	556	110 to 125	18	334	8·5	2·118	11·040
I.	Special triple-compound high-speed condensing ...	542	150 to 170	17	307	8·5	2·000	10·163
J.	Triple-compound low-speed condensing	556	150 to 170	16	297	8·5	1·882	9·810
K.	,, ,, ,, ,, ...	556	160 to 170	15	278	8·5	1·765	9·200
L.	Ditto for probable maximum results..........	556	160 to 170	14	259	9·5	1·474	7·683

Table II.—Approximate First Cost per Net Horse-power.

a.	l.	m.	n.	o.
Designation.	Engines erected and connected.	Boilers erected and connected.	Buildings and chimney.	Total with 2½ per cent. inspection and 6 per cent. interest during construction.
	Shillings.	Shillings.	Shillings.	Shillings.
A.	73	109·25	63·25	266·3
B.	104	98·5	59·25	284
C.	87·5	86	54·7	247·8
D.	108·3	90	52·25	272·3
E.	87·5	72·8	49·8	228
F.	112·5	68	48	248
G.	102	66	47·3	234
H.	125	62·25	45·5	251·5
I.	120·8	64	43·7	248
J.	156·25	62	43	283·3
K.	187·5	58	34·8	304
L.	187·5	54	34	299

Table IV.—Approximate total cost per net horse-power per year for electric railroad or other variable work requiring 50 per cent. extra plant to obtain 500 h.p. average. Insurance increased to 1½ per cent., engine renewals to 4 per cent., and boiler renewals to 5 per cent.

Designation.	365 days of 20 hours, cost of coal per ton of 2,240lb.			
	8s. 4d.	12s. 6d.	16s. 8d.	20s. 10d.
	Shillings.	Shillings.	Shillings.	Shillings.
A.	259	319	379	439
B.	244·3	298·5	352·5	406·75
C.	223	270·3	317·6	365
D.	220·2	263·8	307·5	351
E.	200·2	240·2	280·2	320 2
F.	194·1	231·5	269	306
G.	192·6	229	265·3	301·75
H.	186	219·4	253	286·6
I.	181	213·6	244·6	275·5
J.	184·4	214·25	244	274
K.	185·25	213·25	241·2	269·2
L.	179·9	203·2	226·6	250

TABLE III.—Approximate Working Expenses per Net Horse-power per Year.

a.	p.	q.	r.	s.	t.	u.	v.	w.	x.	A.	B.	C.	D.
Designation.	Supplies and repairs. 365 days, 20 hours.	Wages. 365 days, 20 hours.	I'surance, taxes, renewals total 5 per cent. of cost.	Interest, 10 per cent. of cost.	Total of all expenses except coal. 365 days, 20 hours.	Cost of coal used, 365 days, 20 hours, per ton of 2,240lb. delivered.				Total expenses, 365 days of 20 hours, cost of coal per ton of 2,240lb.			
						s. d. 8 4	s. d. 12 6	s. d. 16 8	s. d. 20 10	s. d. 8 4	s. d. 12 6	s. d. 16 8	s. d. 20 10
	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.	Shillings.
A.	29·2	47·25	12·3	26·7	115·45	120	180	240	300	235·4	295·4	355·4	415·4
B.	25	44·3	13	28·4	110·7	108·2	162·3	216·3	270·5	219	273	327	381·2
C.	29·2	41	11·4	24·46	106·06	94·6	141·8	189·1	236·4	201	247·8	295·2	342·5
D.	29·2	39·3	12·5	25·6	106·6	87·3	130·9	174·6	218·2	194	237·5	280·6	324·8
E.	29·2	37·6	10·5	22·8	100·1	80	120	160	200	180	220	260	300
F.	25	36·3	11·4	24·46	97·16	74·6	112	149·2	186·5	172	209·2	246·4	283·7
G.	29·2	35·8	10·8	23·3	99·1	72·75	109	145·5	181·8	172	208	244·6	281
H.	25	34·5	11·6	25	96·1	67·2	100·75	134·3	168	163 3	196·8	230·4	264
I.	29·2	33·2	11·5	24·46	98·36	61·83	92·75	123·6	154·6	160·2	191	222	253
J.	25	32·7	13	28·3	99	59·66	89·5	119·3	149·2	158	188·5	218·3	248·2
K.	25	31·8	14	30·4	101·2	56	84	112	139·9	157	185·2	213·2	241
L.	25	37	13·8	29·9	105·7	46·75	70·125	93·5	117	152	175·8	199·2	222·7

the engines equals an amount which represents a saving of 6¼ per cent. of fuel, then the cost to the owner of the steam plant will be exactly the same in the two cases, since in one case he will pay in additional interest or dividends on the capital invested the same sum as he will pay for additional fuel if he uses the cheaper engine. The cumulation of costs, other than for fuel or interest, reduces the saving due to economical consumption of fuel, and interest and dividends may neutralise percentages already made small from the first-named cause. Original cost of plant is important, where on one hand money is dear, or coal is cheap or work irregular. When interest charges are considered, the number of hours an engine operates in a year has a very important influence on the question of first cost, as such charges for a given steam plant will be exactly the same, whether the latter be operated one hour per day during part of the year, or 24 hours per day for the entire year, and the interest will also be the same whether the coal used cost 1dol. or 10dol. per ton. The saving in the total cost of coal consumed, either during the short hours or at the low price per ton, will not warrant the adoption of high-priced steam machinery.

Various other conditions operate to equalise the cost of different kinds of steam machinery. Smaller boilers are required with more economical engines, and the saving in cost of boilers partly compensates for the higher cost of the engines. Coal is now cheap, and economical engines, though lower than formerly, are still relatively high.

Modern steam-engines may be divided into high-speed and low-speed engines. High-speed engines are of comparatively short stroke and develop approximately the same piston speed as long-stroke engines by an increased number of revolutions. In most high-speed engines the steam is distributed and cut off by a lap valve operated by a governor revolving with the main shaft, which acts to move the centre of the eccentric in a line transverse to the crank at a distance from the centre of the shaft equal to the lead. The effect is to modify the cut off, as in the link motion, by reducing the throw so that the angular motion required to move the valve through its double laps forms a greater or less proportion of the whole motion and therefore varies the angle of steam admission while the lead is maintained substantially uniform.

In Table I. the engine marked J is designed for economy in construction rather than the highest economy in fuel Engine K is a low-speed triple compound, and results are the best that can be attained under ordinary average practice, even with the best machinery. Engine L is operated still more economically, by means of boilers of unusual economy and careful firing, etc., 1dol. per day being added to labour account. Results are maximum with best care available. All engines are assumed to be reliable, and no large allowance has been made for breakdowns. The total loss due to friction of the engine and jack-shaft of the low-speed engine is 10 per cent. and for the high-speed engines 8 per cent. Column *f* shows the feed-water per indicated horse-power per hour assumed for comparison. These figures can be depended upon in practice with varying loads affecting the economy. Engines with a uniform load will give lower results, but engines generating electric current for electric railways or subject to variable loads of any kind will rarely show economies as low as column *f*.

Column *g* shows the commercial horse-power (C.H.P.) of the boilers required to furnish steam to engines of the indicated horse-power shown in column *c*. The power of a boiler is the quantity of water it will evaporate under normal conditions, and the commercial horse-power of a boiler is 30lb. of water evaporated at 70lb. pressure at a temperature of 100deg. F. The price covers the cost of the better class of "safety boilers" in which the water is contained in tubes, small chambers, or comparatively small shells of unusual strength compared to the large shells of ordinary boilers. Tubular boilers are cheaper, and since increased economy is obtained by increased heating surface, ordinary tubular boilers are selected when large ratios of heating surface to grate are desired, or boilers of the sectional type employed with economisers at the base of the chimney. Increased surface on tubular boilers chokes the draught. Tubular boilers have not the surplus power of sectional, and when the power varies greatly, as in electric work, a greater horse-power of boilers of the tubular type must be provided than of the sectional type. Vertical boilers with small tubes are cheap and efficient with steady work, but must be cleaned periodically.

The final result in the table is not due to the price of the boilers selected. Sectional boilers for pressures not exceeding 125lb. can be purchased and erected in place complete with necessary attachments, furnaces, brick walls, connections to chimney, steam and blow-pipes and other connections, with firetools and fireroom fittings in place ready for regular use for 22dol. (91·6s) per C.H.P., and to carry 150lb. and upward, at 25dol. (104s.) per C.H.P.

The cost in column *l* is approximate. Column *n* is insufficient for elaborate buildings for architectural effect, but could be reduced by using cheap wooden structures.

Columns A-D show that for cheap fuel and short hours the engines of fair economy and least cost give the most economical results when both the cost of the fuel and collateral and interest charges are considered, and the compound engines of comparatively moderate price show better economy, everything considered, than the higher-priced triple-compound engines, if results shown in the last line cannot be obtained in average practice. The various devices which are being urged upon the owners of steam plants should not be purchased unless they will save 25 per cent. of their cost annually. The columns of this table foot up two-thirds of this percentage, and as the attention and repairs of miscellaneous apparatus is great, the additional percentage is fully warranted.

The comparison shows the non-condensing engines inferior at every point to condensing engines. Non-condensing engines are wasteful of fuel when heavily loaded on account of low expansion, and at light loads the back pressure forms a large proportion of the total resistance, whereas condensing engines will maintain their economy through a wider range on account of the reduction of the back pressure. Back pressure affects the economy of triple-compound engines when used non-condensing. Such engines (non-condensing) cannot for irregular loads show any economy over well-designed compound engine (non-condensing) unless the steam pressure is carried to 200lb. or upward, and the size of the cylinders proportioned to the average load.

Under some conditions, within the limits of ordinary practice, the prices of economical types of steam machinery compared to price of coal and number of hours' operation, the saving in fuel does not warrant the increase of first cost. This should not be considered a criticism of the practice of others, or serve to discourage the higher development of the steam-engine, as an investigation of this kind, whatever the result, is calculated to broaden the view by taking into consideration more of the conditions of the problem, and thereby enabling the engineer to secure the best results for each particular case. For short hours or low-priced coal, or both, types of steam machinery to secure the greatest economy of fuel are not warranted; but for longer hours and the higher-priced coal the more expensive machinery has a commercial advantage which increases with the price of fuel. In some cases other conditions must be included for a complete solution of the problem. For instance, in large steamers making long voyages, economical machinery secures, in addition to the saving in the cost of fuel, a saving in the space required to carry the machinery and fuel, and thus increases almost in a geometrical ratio the efficiency of the ships. The very large expenditures made by some mining companies to save fuel by the use of expensive steam machinery of special design have been fully warranted by the long hours and high price of coal.

INSTITUTION OF ELECTRICAL ENGINEERS.—Apr. 13

Mr. W. H. Preece, F.R.S., President, in the chair.

The following candidates were balloted for:

Foreign Member.—Charles Walckenaer, 2, Rue Bayard, Paris.

Member.—Charles S. Du Riche Preller, M.A., Ph.D., A.M.I.C.E., F.G.S., F.C.S., 18, Margaret-street, Cavendish-square, W.; Zurich, and Florence.

Associates.—Archibald Allan Crawford, Bombay; James T. Rossiter, 66, Burnaby-gardens, Chiswick; Charles Bottomley Smith, the Hove Electric Lighting Co., Cromwell-road, Hove, Brighton; Herbert Whitney Smith, Towerfield, Northampton; W. P. Steinthal, Fair View, Alsager, Cheshire.

Students.—Esmond Morgan Abdel-Malek, 28, Great Coram-street, Russell-square, W.C.; Ernest Bowyer, 28, Anerley-park, S.E.; Charles D. Burnet, "Tantallon," 5, Oakhill-road, Putney, S.W.; Francis William Hurt, Sandal Magna Vicarage, Wakefield; John Thoburn McGaw, Hatsfield, Betchworth, Surrey; Thomas Whiteford, 39, Westbourne Park-crescent, W.

The following paper was then read:

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS.

BY ALBION T. SNELL, MEMBER.

Multiphase alternate-current working, although demonstrated at the Frankfort Exhibition, has not yet found favour either in England or America; but on the Continent the Drehstrom has been used with success for several important schemes, and larger applications lie in the near future. It has been pointed out, with justice, that multiphase alternate currents offer no real advantage in comparison with single-phase ones for merely the transmission, as distinguished from the distribution, of power. It is, perhaps, for distribution proper—*i.e.*, where a number of motors, varying in size and lying over an extended area, have to be supplied from a common and probably distant source of power—that the multiphase systems find their field of usefulness.

The object of this paper is to discuss the various alternate-current motors now in the market, and, perhaps, to see how far they lend themselves to a system of distribution in which the principal conditions of supply may be stated as follows: 1. The pressure in the transmission mains must be as high as possible. 2. The pressure must be maintained fairly constant at the centre of distribution. 3. The pressure at the motor and lamp terminals must be comparatively low; and 4. The system must admit of lighting all over the area of distribution by the use of proper converters. These points are by no means easy to obtain even singly, and when they must be concurrent the difficulty is much enhanced.

1. SINGLE-PHASE SYNCHRONOUS ALTERNATE-CURRENT MOTORS.

Single-phase synchronous alternate-current motors have been used since the memorable experiments at the North Foreland in 1884, but comparatively little progress has been made in their application to general commercial purposes; and the reason for this probably lies in the fact that the synchronous system is practically limited to a single pair of machines, for the starting of the motor by auxiliary power is not a prohibitive objection with one large machine, although out of the question with a number. On the other hand, the high efficiency of synchronous motors and their perfect regulation of speed with varying loads renders them especially suitable for a variety of purposes; and no efforts have been wanting on the part of scientists and engineers to place a self-starting single-phase motor in the market, but hitherto without success. It will serve no useful end to describe in detail all the various attempts, but the limiting conditions may be best gauged by a consideration of the difficulties involved, and by a few typical examples showing the directions in which solutions have been tried.

The following peculiarities are found in alternate-current working with single-phase synchronous generators and motors: (*a*) The dynamos are always separately excited. (*b*) The motors are usually separately excited in order to save the complication of commutators. (*c*) The motors must be raised approximately to the speed of synchronism before the dynamo circuit can be closed. (*d*) The torque on any motor must not exceed a certain value or the machine will stop. (*e*) The current lags behind the pressure by an angle which is a maximum when the motor is running light; and there may be a relatively large idle current, which, though representing little energy at the motor, causes a serious loss in the supply mains and dynamo armature. (*f*) Motors must be designed not only with reference to the pressure of supply, but also with regard to the frequency of the current, and hence are only suitable for working on particular circuits; and (*g*) Alternate motors, excited by either a direct or by a single-phase alternating current, have dead points in each period of alternation.

The earliest attempt to meet these conditions was by laminating the field magnets of an ordinary direct-current motor and modifying the winding so as to make the self-induction as small as possible. The results were not successful. With shunt windings it is found to be practically impossible to excite the magnets excepting with large currents and few turns of wire, and even then, owing to the difference of phase between the field and armature currents, the torque is insignificant compared with the current used, and the dead points may involve difficulties. The series winding is better, but still useless for commercial requirements; for though by carefully adjusting the windings it is possible to obtain a smaller lag, the weight output is still very small and the dead points remain.

The loss by hysteresis in each case is so great as to be probably prohibitive, even neglecting the other objections. The crux is the frequency. This would, most likely, have to be reduced to something of the order of 20 ∼ per second, and such a current would be useless for lighting, and would largely increase the difficulty from dead points. Indeed, from this aspect the frequency should be high, and the armature heavy enough to act as a flywheel. The author has made a number of experiments in this direction, and finds that the eye can easily detect 30 ∼ per second, and he believes from this cause it would not be expedient to work at less than from 40 to 45 ∼.

Another method involves the transformer principle, but is really only applicable to small machines. It originated with Mr. Jacobi, when one of the author's assistants, and a few motors were designed by them conjointly. With this type the armature is wound in the usual way, drum or cylinder, and has a collector of the ordinary type. The field cores are laminated and wound with two windings, one of which is coupled to the supply mains, and the other connected across the armature terminals, thus forming a secondary circuit. Such a motor gives a considerable torque, is self-starting, and has probably an efficiency of 60 per cent. in 1-h.p. machines. It has dead points in each alternation undoubtedly, but they are not very apparent. The chief difficulty is that owing to the configuration of the iron of both field and armature, and the air gap, the number of lines of force passing through the two circuits is not the same; and, moreover, there is a considerable lag between the primary pressure and current. And also, which is equally important, the primary and secondary currents are not in phase. With small armatures having few turns per coil the sparking is little, the best results being obtained when the axis of the armature field is at 90deg., or thereabouts, to that due to the exciting current. The armatures may advantageously be wound with two circuits, so as to avoid short-circuiting coils beneath the brushes.

2. USE OF CONDENSERS.

The next step in alternate-motor design was the attempt to balance the self-induction of the shunt-wound field magnets by a condenser, placed in series with the windings. If the condenser be correctly chosen for the frequency and the capacity of the circuit, its E.M.F. will theoretically be equal and opposite to the counter E.M.F. of the magnets, and so the exciting current will only have to be driven against the ohmic resistance of the winding, and, moreover, the pressure and the field current will be in phase. The armature has but small self-induction, and so its current will be also nearly in phase with the field current, and the maximum magnetism in field and armature will occur at approximately the same instant of time. Therefore the energy absorbed by the motor can be very nearly gauged by the product of the number of volts and amperes. In practice, owing to the armature reactions, the condenser will most likely not exactly counteract the counter E.M.F. at all loads. And again, even assuming such machines to be commercially practicable, they would only be suitable for one periodic time. If condensers were applied to series-wound motors, they would be coupled in shunt to the field windings; but the objections above mentioned are equally applicable. A most important point to be noticed in connection with condensers used in this manner, is the relatively high pressure which might occur at the field terminals owing to fluctuations in the current. This difficulty can be obviated by arranging the condenser and windings in sections, but such a plan is open to objection on the score of complication. Messrs. Hutin and Leblanc* have recently patented several modifications of designs involving condensers.

An interesting modification of the shunt-wound single-phase motor has been designed by Messrs. Stanley and Kelly. It is well recognised that the lag of the armature current does not coincide with that of the field current in an ordinary shunt-wound motor supplied with an alternating current, and hence the torque is not proportional to the armature current, but has a maximum for some particular value which must be determined experimentally for each machine. To meet this difficulty these gentlemen place a condenser in series with the shunt coils, and put short-circuited coils in recesses cut in the pole-pieces. These coils carry currents induced by, and therefore proportional to, the armature current, but always in such a direction as to tend to decrease the self-induction of the armature coils, and consequently the lag of its current also. The arrangement has the disadvantage of raising the interpolar resistance, and is likely to cause serious distortion in the main field.

It has also been proposed to supply the idle currents prevailing with alternate-current working by suitable condensers placed across the supply mains, preferably at the transformer sub-stations.

3. SPLIT-CURRENT ROTARY-FIELD MOTORS.

Another attempt has been made in the direction of splitting the main current into two separate branches with phase differences of 90deg., and so producing a bi-phase rotary magnetic field, the armature circuit being closed on itself, or through an external resistance, and carrying a current induced by the revolving field. In principle this machine is similar to a Tesla motor supplied with two separate currents, one of them lagging 90deg. If a current be divided into two circuits with different coefficients of self-induction, the current in one will lag behind that in the other; and if the one circuit have no self-induction but capacity, and the other have relatively a large self-induction, then the phase difference can be made as near 90deg. as desired. Such a machine has been designed by Messrs. Hutin and Leblanc, but the author does not know how far it has been successful in practice. The points gained by this arrangement, however, mark a considerable advance in the design of alternate motors for use off ordinary supply mains. The motor is self-starting; non-synchronous; if stopped through overloading, will start again as soon as the excess of load is removed; and is self-exciting. But it appears to be still far from perfect; for, owing to the armature reaction on the field, it is difficult to see how the current, in the circuit containing the condenser, can be self-adjusting for varying loads with a pressure of supply ; and consequently the output of such tor will probably be less than that of a Tesla one with two endent currents. The difficulties attending the condenser recisely the same as those previously referred to with the ironous type of motor.

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* Under the auspices of Messrs. Rothschild, who have generously voted the sum of 175,000f. to enable them to carry out experiments with alternate motors on a commercial basis.

ssrs. Stanley and Kelly have recently devised a quadrature r, which presents some interesting features. In one of the its is placed a solenoid with low ohmic resistance, but large nduction ; and in the other circuit is a series of secondary ries which have capacity, and, therefore, act as a condenser. esult arrived at is a lag of 45deg. in the curent of the inve circuit, and a corresponding advance in the capacity h, the result being a total difference of phase of about g. between the two currents. The battery does not need ve large storage capacity ; and as the number of plates is ged so as just to prevent electrolysis there will be no ming." But lead plates used in this manner in diluted sulc acid rapidly sulphate, and hence are likely to give le. Iron plates in caustic soda are also rapidly affected, ven carbon soon crumbles away. Platinum seems to be nly reliable material, and this at its present price is too .

4. Multiphase Alternate Motors.

of. Ferraris in 1885 experimented with multiphase currents, published his results in March, 1888, at Turin ; and in of the same year Tesla showed a rotary motor running four wires ; and Bradley, Haselwander, Wenstrom, Elihu son, Dobrowolski, Brown, and others have introduced us modifications and improvements. The first practical nstration was made by Dobrowolski and Brown with the kfort-Lauffen plant.

should be noticed that in all rotary-field motors and mos it is not the current, but the resulting magnetism, otates ; thus, if there are two circuits and four poles, the etism will be displaced 90deg. with each wave of current. der to see this more fully, a simple case may be instanced.

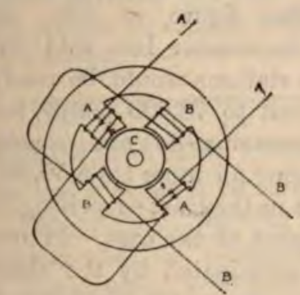

Fig. 1.

1 is a four-pole diphase motor of elementary type, with a d-circuit armature, having neither brushes nor commu. There are two alternating exciting circuits, A A_1 and in quadrature.

ppose that A and A_1 be magnetised so as to cause lines of to pass from A to A_1 through the armature C. Then B B_1 will be neutral, for there will be no current in them at moment.

xt, the current in A A_1 will gradually die away, and that B_1 will steadily rise in an equal and opposite ratio until magnetic flux from B to B_1 and A and A_1 are neutral.

is cycle will be repeated, but with one alteration—the nt in A A_1 will rise to a negative maximum (assuming it to been positive before), and the flux will be in the direction to A ; and in the next wave from B_1 to B. Carefully g these changes, it is seen that the magnetic field has ed once for a complete ∿ in each of the circuits, and, fore, the speed of the field rotation is $\frac{N}{n}$, where N is the ber of ∿ per second, and n is the number of pairs of in one circuit. In the case referred to, since $n=1$, the utions of the magnetic field will be the same as the number ∿. To make a diphase dynamo it is necessary to replace losed-circuit armature by a suitable electromagnet having any free poles as there are poles in one of the alternatent circuits, to excite this magnet with a continuous current, o cause it to revolve.*

en diphase periodic currents will be induced in the two its A A_1 and B B_1, the phase difference between them 90deg.

thematically the currents may be expressed thus :

$$\text{That in A } A_1 = \text{K} \sin \alpha$$

$$\text{,, ,, B } B_1 = \text{K} \cos \alpha = \text{K} \sin \left(\alpha - \frac{\pi}{2} \right)$$

which shows the phase difference between the two currents. Now K is a constant for the particular machine, and α is a measure of the angular motion of the field. It will be seen that the current in A A_1 is a maximum when α is equal to $\frac{\pi}{2}$ and $\frac{3}{2}\pi$, and is zero when α is equal to O and π ; the converse of this is the case with the current in B B_1.

Diphase systems require either four wires—*i.e.*, two for each circuit—or else the common return must be of double section for the same loss. This is inconvenient on account of both cost and complexity; but a far greater objection for large plants seems to be the apparently excessive variation in the field excitation, yet this view is strongly combated by many competent engineers. Let Fig. 2 be carefully examined.

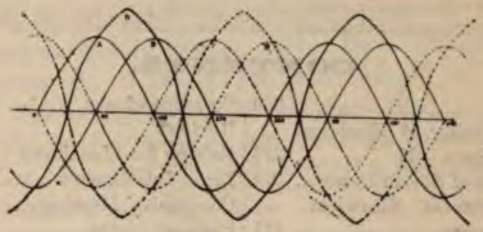

Fig. 2.

Curves A and B show the current-fluctuations in the two circuits, and D that in the common return. The magnetic field will be caused by A and B alone, and, therefore, will be proportional to their sum at any instant. When A is a maximum, B is zero, and the induction at this moment is proportional to the current in A alone, and is equal to, say, C sin $\frac{\pi}{2}$ = C. When A and B are equal, as at 135deg. of field rotation, the induction is proportional to 2 C sin 135deg. = C 1·4. Thus the excitation varies between 1 and 1·4, the difference being nearly 30 per cent. of the highest value. The mean variation will be only about 15 per cent., it is true, but hysteresis and self-induction are proportional to the limiting values of the excitation, and eddy currents approximately to the squares of these differences.

Self-induction decreases the output for a given weight of material, and also by increasing the lag may largely augment the idle current for small loads.

To illustrate the fluctuation of the field excitation and consequent induction the sign of the negative curves in Fig. 2 may be changed, and they may be plotted above the time line as if they were positive in value ; or two fresh complete curves may be drawn, as shown in dotted lines and marked A_1 and B_1 in Fig. 2, referring to the next two impulses of current immediately succeeding waves A and B.

Both these diagrams are justified by the consideration that each circuit in the motor contains at least two coils wound in opposite directions, and thus produces poles of different signs ; and, therefore, the magnetism rotates continuously.

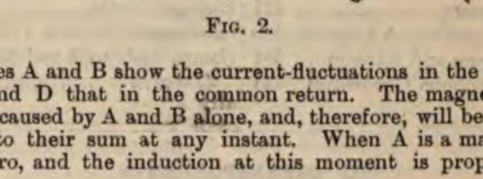

Fig. 3.

In Fig. 3 the sign of the negative curves has been changed, and the excitation fluctuation is shown by the top curves, which may be regarded as having reference to one of the poles of the rotary field, say the north pole ; while with the double arrangement shown in Fig. 2, since there are two sets of curves—one positive and the other negative—the variations of both poles are indicated. But as the fluctuations are sufficiently defined by the first method, the duplication involved in the latter seems to be unnecessary.

In the preceding considerations the armature reactions have been neglected. These are not easily estimated without some experimental acquaintance with the machine in question. But their effect will be a maximum at starting, and will decrease as the armature speed increases, and would be nil if the speed of armature and field coincided—*i.e.*, if the motor worked synchronously. The last condition is unattainable even with no load, for the friction of the bearings and air requires a certain amount of current in the armature to overcome it. Generally speaking, the armature reactions tend to weaken the resultant magnetic field and also to lessen the torque for a given current.

(To be continued.)

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otary magnetic-field machines under certain conditions are sible. See *Electrical Review*, February 10th, 1893, in which xperiment is given showing the reversibility of a "threer."

THE

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CITY OF LONDON—A FORECAST.

The report of the City of London Electric Lighting Company for the half-year ending December 31, 1892, affords some interesting information for a possible forecast of the profits of that undertaking. On June 30, 1892, there were, according to the September report, 11,800 8-c.p. lamps connected, and this figure had increased in September to 20,000. The receipts for current sold for private lighting during the same period amounted to £5,576. 8s. 5d., which at 8d. gives 167,292 units, or earnings at the rate of about 14s. per lamp per annum. As these earnings were from lamps installed in a large proportion of shops and public buildings, and a correspondingly small proportion of private offices, which constitutes by far the largest source of demand for light in the City, 14s. may be regarded as a high figure, because it is more likely to decrease than to rise, for the large day and night loads in the great publishing and manufacturing establishments will have to be supplied at a considerable deduction for quantity, and it is a question how long it will be before the 8d. now charged will have to be reduced to 7d. It would, therefore, be safer to estimate this figure at 12s. Although the chairman in September last told us he expected the company's stations would be ready by this time to supply current to 78,000 lamps, he now tells us that the connections do not exceed 34,000, the applications being for more than 50,000. This over-estimate is not in the least surprising, considering all the circumstances of the case. It may reasonably, therefore, be anticipated by the shareholders that the estimate in the report of March 23, 1893, now before us is somewhat exaggerated, and that at the end of 1893 the sufficiency of plant for 140,000 lamps will be still a good way off. That the means of distribution will be ample, the chairman has given every assurance, but we feel that his reliance on the supply of plant, the efficiency of much of which, owing to its novel form and dimensions, was not proved even so late as at the end of 1892, may be anything but realisable.

Assuming that there will be plant sufficient and applications for 100,000 lamps (connected up) by the end of 1893, and that the gross earning of each lamp is 12s., the company may be then congratulated that it has reached a stage when its rate of gross earnings on the private lighting will amount to £60,000 per annum. With this figure before us the standing loss on public lighting, which is inevitable with a contract that requires the company to supply at nearly 2½d. a unit, is of little consequence. What may be available for distribution to the shareholders at the end of 1893 is a figure which from the experience of other supply companies cannot be easily estimated. The following calculation would lead to the supposition that the ordinary shareholders must defer their hopes.

Turning to the statement of share capital in the report, it will be found that £448,000 had been spent up to December 31, 1892, £400,000 of which is money subscribed for ordinary shares, and £48,000 for preference shares. The private lighting plant to carry the expected next winter's load should certainly not have a less capacity than 6,000 h.p., which, at £34 a horse-power, will have cost the company not less than £200,000, of which there will most probably be a remaining liability of not less than the unpaid calls on the 20,000 preference shares that have been issued—namely, £119,000—so that it is not unreasonable to anticipate that the total paid-up and expended capital by next 31st December will amount to £600,000. Upon £200,000 of this the preference shareholders ought to receive for 1893 £12,000. As the gross earning capacity is now only 34,000 × 12s. = £20,400, and, as we have pointed out, it will probably not exceed in annual rate £60,000 at the end of the year, it will be fair to estimate gross earnings in 1893 at £40,000, and the net revenue to be derived from the same to be ten or twelve thousand pounds—or no more than sufficient to pay 6 per cent. to the preference-holders.

In this respect the ordinary shareholders of the City of London Electric Lighting Company are to be congratulated, when their case is compared with that of the older and pioneer companies which bore the brunt of early difficulties. If they receive 5 per cent. for their investment at the end of 1894 they will have done better than any other electric lighting investors, and we see no reason to doubt the probability of such a result.

WOODHOUSE AND RAWSON.

On Monday last a meeting of creditors was held to consider a suggestion of the late trustees for the debenture-holders that the company should be reconstructed. The meeting would call for no remarks from us had not Mr. Pope put his position as one of the directors very pointedly, and emphatically stated that he had heard something about a combination of shareholders to fight a test case against the directors. While he had sacrificed time and money in the interests of the company, and especially in the interests of the debenture-holders, if he were attacked upon the prospectus he would fight to the last halfpenny he had. This indignation was all very well in its way, and no doubt impressed the shareholders present as to the futility of fighting for their lost property. We have said before, and we say it again, we have no sympathy with the shareholder. He deserves to lose, and richly deserves the fate which has overtaken him. So long as 15 per cent. was paid he made no bones about receiving it, nor, though warned, did he enquire too curiously into the balance-sheet. Though we as outsiders might be in order in condemning the management of the company, it was not the best of taste for shareholders and others at this meeting to use harsh language. They agreed with the management when the wind was fair. They knew the concern was basing its prosperity upon company-mongering, and they took no step to stop such work. It is the way of a contemptible snob to kick men who are down when the men who so kick were the very men to support the actions which promised fair dividends. Sir Rawson Rawson and Mr. Pope were both correct in the way they put the matter. The company is gone past redemption. The assets, such as they are, should be realised to the best advantage, and may then be found sufficient to pay the debenture-holders. The outlook for the trade creditors is not promising, but they certainly will get nothing unless the assets be carefully realised. The one point upon which we disagree with Mr. Pope is that a large debenture interest was made when the promoters were paid, and paid, as it now seems, by placing to credit in the balance-sheet assets which no sane person could or can argue were real and tangible. Under a properly-constructed balance-sheet some £50,000 debentures would never have been created, and our point is, that in the distribution of assets those debentures should be cancelled. Unfortunately, they may have got into—we must use the term—innocent hands, and in such a case the innocent holders should have remedy against the original holders. The case is simple, though the law may not see it. Broadly, £50,000 debentures were created upon incorrect balance-sheets. The law ought to ask—and by this we mean the official receiver ought legally to determine—how far, if at all, these balance-sheets contravened the law. If it was held that they wilfully misled, then the £50,000, or rather the £70,000, paid should be recovered; and by this recovery the position of the remaining debenture-holders, the trade creditors, and to some extent the shareholders, would be far better than at present. The meeting, at the instigation of its conveners, came to the conclusion that the best plan was to leave such points as they are, and to do the best they could with matters as they stand at present. Our opinion is that the legality of the payment of that £70,000 ought to be tested. The three petitions for compulsory winding up have been abandoned in favour of a supervision order.

So much for the past; now as to the suggested future. As put to the meeting, the suggestion is for someone to purchase the part of the business they think will pay—to carry on this part as a new business upon which the old creditors have no claim. That is all. It means the purchasers will get a good thing cheaply and so make money. The remaining assets, after the plum has been taken out, are to be realised to the best ability. The creditors get, first, the amount paid for the "plum," secondly, the amount realised in the sweet by-and-by for the remaining assets; meanwhile the buyers get the plum and what it brings them.

The amount required to carry on the business connected with the plum is not great: would it not be better for creditors and shareholders for the official receiver and his manager to carry on the "plum" part of the business for the benefit of all rather than to sell it for the benefit of the few?

THE TELEPHONE COMPANIES.

On February 17, our contemporary the *Electrical Review* wrote: "The system proposed by the New Telephone Company is old; has been tried and failed; and no evidence is forthcoming that the causes of failure have been eliminated." We fancied this was a somewhat sweeping assertion and an erring one, as we had followed fairly, as we imagine, the workings of the New Telephone Company and the system considered best by its adviser. In our issue of February 17 we referred to the system advised as the "Mann" system, and insisted upon the facts that this was the system advocated by Mr. A. R. Bennett (the adviser of the New Telephone Company), and that so far as we know, it had not been tried and failed. On February 24, our contemporary, returning to the matter, seemed to discredit anything ever done by Mann, and gave all the credit to Law. In our opinion this gave rise to the possibility of error, as the name "Law" had been usually associated on this side of the Atlantic, at any rate, with a series system, and no branched or multiple system had been recognised here until Mann showed at Dundee how effective it might be. Then we endeavoured to restrict the controversy to ascertain what was meant by Law and what by Mann. Our contemporary insists that Law invented not only the series, but the multiple system, and is entitled to all credit, and that Mann has done nothing but take what was known before, and also that the multiple system had been largely tried and failed. We attempted to let down lightly and agreed that (Shaw) Law might have indicated a multiple system, but it was never made practical till Mann modified it; and we must now insist somewhat strongly upon this, and claim that Mann's name, and not the Law Company's, should be associated with the multiple or branch system. We must also go a little further, and claim that, whatever else the New Telephone Company desired, it advocated, and its advisers advocated, the "Mann" system, and that this system does not come within the category of "being old," or "has been tried and failed." On March 17 we put four plain questions with a view of agreeing, if possible, what the real advice of the New Telephone Company or of Mr. A. R. Bennett, its adviser, was. These questions were not categorically answered, because the reply was probably directed to the determination of what the Law Company had really indicated, and it was, shall we say, proved that the Law system comprised both a "series" and a "multiple" system. This narrowed the ground considerably from the fact that no one disputes but that the Law (series) system has been tried and failed. Our contention is that both the Law (series) and (multiple) systems in the hands of the Law Company have been tried and failed, but to please our contemporary, and come, if possible, into perfect accord, we will modify the remainder of our contention to: that the Mann modification of the Law branch system, which modification is advocated by the advisers of the New Telephone Company, has not failed, but has been a success. Elsewhere we insert a letter corroborative of our contention that Mann did something more than the Law Company, and that this something meant the difference between success and failure. Mann succeeded because of this modification, while the Law Company failed. Without going further, we may once more put our position *very clearly*:

We contend that Mann really did something that the Law Company did not do; and

That Mann's modified Law branch system succeeded; and that

This modified system has always been recognised here as the Mann system, and not the Law system; also

The Mann modification of the Law branch system is the system advocated by the advisers of the New Telephone Company; and hence

The advisers of the New Telephone Company have not advocated an old system that has been tried and failed.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY—INDIAN EXPERIENCE—MANN AND LAW.

SIR,—I have followed with interest the controversy *re* the Law and Mann systems, and notice that some question has arisen respecting the change which took place in India, and the nature of the switching system which originally obtained there. As the manager and engineer in charge of the Bengal Telephone Company's exchanges in Calcutta—1884-8—and the person responsible for the change referred to, I may perhaps be permitted to trouble you on the subject.

First, about the system in use. When I went to India I found the branched Law system in operation, but this system differed from that introduced by Mr. Mann in Dundee, and subsequently adopted in other British exchanges, in at least one very important—nay, material—point. The subscribers' instruments in Calcutta were not provided with ringing apparatus, so that the exchange had to perform all the necessary ringing of subscribers' bells. An interrupted conversation consequently could not be resumed without an appeal, *viâ* the circuit wire, to the operator to ring "So-and-So's" bell again. The attention of the operator was thus diverted from the actual switching, and the rapidity attained by Mr. Mann, and for which his system has become so justly renowned, was out of the question in Calcutta. In fact, the Calcutta system was the Law system with the circuit wires branched, instead of being looped through the subscribers' instruments, and the switching operations were practically as described by "Preece and Maier," page 300.

Now, Mr. Mann in Dundee adopted the branched Law, with the vital difference that all the necessary ringing was thrown on the subscribers, so that the operators had nothing to do but make and unmake connections. Instead of concentrating an arduous labour at one point, and in a few hands, Mann spread it all over the town or area, and subdivided it so that it became no labour at all. I believe this innovation was quite original with Mann, and this, coupled with good management, careful attention to details of the construction of lines and instruments and selection of staff, is quite sufficient to account for the undoubted success of the system established by him in Dundee.

The statement which appears in the *Electrical Review* of the 7th inst., page 400, has considerably astonished me. I refer to the following passage: "What we say is that Mann did nothing; made no alteration, modification, or improvement which differed from that previously in use."

Now, putting aside the question of improvement, the addition of the magneto instruments alone to the branched Law system may surely be regarded both as an alteration and a modification. This combination *may* have existed previously, but I have certainly never heard of it, and should be glad to know if such is really the case. To endeavour to make out, therefore, that Shaw, the inventor of the Law system, is entitled to all the credit, is to deprive one of our most original British telephonists of the praise justly due to him as the first to show how a system which had many drawbacks originally could be made to surpass the best-known systems of the day. Unless Mann's Dundee system has been tried and abandoned in India since the early part of 1888, I can say, without hesitation, that such is not the case.

Now for the reason why the branched Law system was abandoned in Calcutta. When I took charge, in November, 1884, I found the service anything but satisfactory, and complaints so numerous that it soon became evident that a radical alteration would have to be made. I had not to go far to get to the bottom of the trouble. Two systems were in operation; the majority of the subscribers were connected on the branched Law and the remainder on the ordinary magnet system. The complaints were chiefly from subscribers on the former. Hardly a day passed without one or more of the circuit wires being earthed, either through contacts outside between them and the subscribers' wires used for conversation, the "leading-in" wires, or in the instruments. This was undoubtedly due to defects in the outside construction and instruments; the latter—although perhaps at the time they were put in they were the best in the market of their class—proved most unreliable and gave endless trouble.

Early in 1885 I strongly urged the advisability of a complete change and the adoption of a simple uniform system, and it became a question as to which it should be—the "Mann" as established in Dundee, or an ordinary magneto system. The adoption of the Mann system meant a large outlay on reconstruction, in addition to the cost of the magneto bells required for the subscribers on the branched Law system, and a staff of operators and inspectors far smarter and more intelligent than those obtainable in Calcutta at a reasonable rate of pay. In fact, it meant a considerable increase of expenditure all round.

Having regard to this, and the hopelessness of establishing a good and reliable service without going in for general reconstruction and an expensive staff, I strongly recommended the company to adopt a simple magneto system, and in 1886 new switchboards were made and fitted up in the exchange, the old Law bell instruments taken out, and magneto bells of the latest pattern substituted. The result was a very material improvement in the service. The conditions of working are very different in India to those existing in England, or, I should think, in Europe generally; and although I am strongly in favour of a system which dispenses with indicators and a multiplicity of contact springs on the switchboards, and which, where properly established in a really workmanlike manner, admits of a rapidity in making and unmaking connections unattainable by the ordinary system of signalling, under similar conditions I should hold the same views regarding the Calcutta system to-day that I held when I was out there.

As to the general understanding as to what constituted the Mann system, I think I have clearly shown that it was considered to differ very materially from the Law system by the fact that it was suggested as a substitute for the system in use in Calcutta in 1884, which was nothing more nor less than the Law system branched and not looped.

April 10, 1893. A. SANDFORD.

THE TRAINING OF ELECTRICAL ENGINEERS.

SIR,—The information you are eliciting as to the requirements of firms of engineers in those entering the profession is most valuable to those engaged in teaching. It must, however, be recollected that these requirements are only one factor in the questions to be decided, and it is to be hoped that in expressing their opinions the firms who are kind enough to assist engineering students in this way will keep in mind the requirements of subsequent years of an engineer's life, and not consider only the requirements the employer values in an apprentice. A school that taught a student to really understand the nature of self-induction, for instance, would be conferring a more permanently valuable acquisition on the student than one that *only* taught him how to measure it with some instrument that read the result by a pointer on a scale without the student's understanding one bit what he was measuring, nor how he measured it. And yet this latter student might be much more useful to his employer than the other student, who was really better equipped for his life's work. Of course, both are, as usual, best, but one must put up with the possible; and a large number of young men are so stupid, or so badly trained by memory work in schools, that though they can learn to put a penny in the slot as well as a well-trained dog, or perhaps a little better, yet it takes a great deal of time, pains, and trouble to get into their heads the least idea of, or even interest in, the means by which the chocolate emerges. Those who are clever themselves and have not had much experience in teaching, can hardly believe how very slowly the most elementary general principles are assimilated by the average human mind. And yet it is just the appreciation of general principles that makes all the difference between the intelligent worker who will have a chance of advancing his business, and the routine penny-in-the-slotter who can never be more than a drudge—a useful drudge, maybe, but still only a drudge. It is quite true that most men cannot be much more than drudges, but still everybody should have a chance of advancement; and the mere mechanical work can and will be learnt, while general principles will hardly ever be learnt unless learnt before the stress of all-day-long toil deprives all but a few herculean frames of ability to use fruitfully the hours of rest for hard intellectual work. Those who are familiar with practical calculations are in danger of expecting too much of the same kind of familiarity from students who have had a couple of years to learn so many things in, that it is practically impossible for them to be at all familiar with half of them. This familiarity is learnt after a very few months' apprenticeship, and is concerned with such very different things in different works, that it would certainly be wasting a student's time in school teaching him this familiarity rather than the general principles that are the foundation of all his life's work, and which he will, in all probability, as far as we can judge by past experience, never learn unless he learns them early.

There is one matter that your article seems to assume that schools can teach, and which it is practically impossible for schools to teach. If they could, schools could produce engineers, and apprenticeship would be unnecessary. This is the business or commercial training. This is a large part of what apprenticeship is essential for. How can schools teach students how to deal with workmen on strike, or with a competing firm, or with the hundred and one details of dealings with other men that make a good business and commercial man? Let not anybody expect too much of schools. They cannot supplant: they can only supplement apprenticeship. The sciences involved in arts and manufactures are so numerous and important nowadays that a training in them is essential, and cannot be obtained on works, where it is not anybody's business to explain the principles underlying the operations used to the young learners. This is the business of the school, and if the student leaving school understands these principles it is as much as can reasonably be expected. It is not that applications need be neglected. By all means teach principles by means of applications, but recollect that it is a hundredfold more important for the student to understand the principle than for him to have that kind of familiarity with any particular application that will make him immediately useful to his employer. The future of the student must not be sacrificed to the immediate good of his employer.

Messrs. Crompton seem most reasonable in their remarks, and some information from them as to what the course in "pure mechanical engineering" should be so as to teach the principles that they have found most useful during their whole engineering career, in addition to those that they like in their apprentices, would be of very great assistance to teachers. This whole subject of teaching for the practical applications of science is in its infancy. Now is the time to mould it so that it may grow into a useful manhood.

In conclusion, all should recollect that moral qualities—energy, perseverance, truthfulness, honesty—are a millionfold more important than intellectual and bodily qualities, and that these latter, a healthy mind in a healthy body, are immeasurably more important than any information that can be taught at any school.—Yours, etc.,

GEO. FRAS. FITZGERALD,
Eng. Sch., Trinity College, Dublin.

SIR,—I feel that it is somewhat presumptuous to give my opinion as to how electrical engineers should be trained whilst I am still making myself competent for that distinction. My remarks, however, may be of interest to some, as coming from one on the other side. It is a matter of vital importance to us, as our future prospects depend on our training, whilst the interest the employer feels is too often an unknown quantity. I now realise very fully, and time only strengthens my convictions, that the only way to become an electrical engineer is to be trained as a mechanical engineer—before rather than after. Look at a central generating station, and the answer how to train an electrical engineer is staring one in the face. Before a dynamo can be run, engines and boilers, pumps, water-heaters, economisers, etc., are requisitioned, and the mechanical plant gives more trouble, and requires more attention and repairing than the electrical plant. How can a man manage these unless he has had a mechanical training? There seems to be a confusion between an "electrician" and an "electrical engineer." The extraordinarily rapid development of electric lighting and electric traction within, say, a decade, has changed what were electricians into electrical engineers. Because electric work is now of a heavier character—dynamos of 1,000 h.p. are built, and electric locomotives of 100 h.p.—so that an electrician, strictly speaking, belongs to the class for testing, laboratory, scientific work, etc. In my innocence, when I began to learn the profession of electric lighting and all the rest, I imagined that electric work was of an ethereal nature, and far removed from the grossness of mechanical work. At that time I had never heard of the law of the conservation of energy, and visions of wonderful and delicate apparatus, surrounded by fine wires, arose before me, which required the most dainty handling; but now I find the shifting spanner is often in my hands. If I could have my time over again what I would do is this: Leave school at 17 years of age, having spent the last two years in studies shaped for my future career—such as mathematics and freehand drawing—this last is of immense use to an engineer; then enter a first-class engineer's shop, where engines and boilers are built, as an apprentice for three years, and spend two evenings a week in studying mechanics, etc.; then enter the electrical engineering department of a technical college for two years, and finally go as an apprentice to electrical works, where dynamos and motors, etc., are built, for another two years. This brings me to the age of 24. The system of pupilage in some electric works is often wretched, nearly all the time being wasted, and their parents' money as good as thrown away.—Yours, etc.,

ELECTRIC LIGHT.

REVIEWS.

Electric Shiplighting. By J. W. URQUHART. Crosby Lockwood and Co., London.

Now that even the smallest passenger steamer, and many cargo, and especially oil-boats, are fitted with the electric light, the demand for a book on the subject has arisen. The title-page of this book states that it is written for the use of shipowners and builders, marine electricians, and sea-going engineers. A large ship generally carries a competent electrical engineer trained in this class of work, so that the book will be more especially useful to marine engineers of the smaller steamers who have the electric light directly under their control. These are, as a rule, intelligent men who soon grasp the principles involved. *The introductory chapter* is devoted to these principles: it explains the electric circuit by the hydraulic analogy, but we think that a full and clear explanation of Ohm's law, with some practical numerical examples, would have been more useful. The remark about "personal shock," and that "engineers at sea are more apt to receive it," is not likely to inspire confidence in their minds in attending to dynamos. Seeing that low pressures (often 65 and 80 volts) are always used in marine work, "rubber-soled shoes" are quite needless. Chapter I. contains instructions to shipbuilders as to the choice of the position of the dynamo-room, and states that the best position is about the level of the top of the boilers. This undoubtedly can only apply to the case where a separate engineer looks after the plant, but when the engineer on watch has to do so, a corner of the engine-room or a recess where the plant can be seen is better; if it is placed in an out-of-the-way position, it will be surely neglected. No allusion is made to the advisability of placing the plant fore and aft. Chapter II. deals with engines and methods of driving. The author advocates belt-driving in preference to rope, but our experience teaches us that where space is an object the latter is surely more desirable, and has given satisfaction in numerous cases. The author gives as objections to direct driving, the high speed of the engine, the noise they make, the rigid coupling causing strains from the want of parallelism, and the impracticability of the usual "end play," but he must be aware that these engines, although running at, say, from 200 to 400 revolutions per minute, yet have not a high piston speed, and are constructed for the purpose, with everything arranged to suit the speed. We recall to mind some coupled plants which have run continuously in and out of port for six months without stopping. A specification of a typical electric-light engine suitable for shipwork would be a valuable addition to this chapter in future editions. Chapters III. and IV. refer to dynamos and their management. The author rightly advocates bar drum armatures, but when "in all cases" is added, it should be remembered that it is not advisable to make these below 200 amperes; and as he points out that wire-wound drum armatures should not be used, then Gramme armatures of easy repair should be most suitable. These chapters contain much useful information and to the point. Chapter V., on searchlights and arc lamps, mostly referring to Admiralty work, ought to give the requirements and regulations for the Suez Canal. The author rather mixes up impedance and choking coils with ordinary resistance coils on page 89, as also on page 244. Chapter VI. is devoted to wiring and fitting, the double and single wire systems are discussed, and a good case made out for the former, yet the author acknowledges that the single-wire system is most largely used, and that 90 per cent. of ships' electricians prefer this system after a trial of the double system; also the typical example of shiplighting—that of the White Star "Majestic"—is on the single system. Many of the difficulties and defects of this method given by this book do not exist in practice. This chapter is well written, as also the following two, which give descriptions and illustrations of lamps and fittings. Chapter VIII. gives plain directions for conductivity and insulation testing, whilst giving a general rule for shiplighting circuits. As "10,000,000 divided by the number of lights, the result is the minimum insulation resistance," the book leaves it still in doubt by giving the Phœnix and several other rules with quite different results. The Wheatstone bridge is not explained. Chapter IX. explains the use of accumulators on ships. The concluding chapter, X., gives an account of the "Majestic" as a typical example. The book is a useful one, and the author has evidently taken much pains to render it complete, but the subject is yet wide and could be much extended. As the author heads his last chapter, "Perhaps there is no better instructor for everyday use than practice itself," so there are numerous practical points in the branch of electric lighting which only could be dealt with by those experienced in the work. Some printer's errors, such as (page 68) "conductors consist of 120 copper bars of 46 square inches in sections," are small matters in the book, which is otherwise well and clearly printed.

BELTING FOR MACHINERY.*

BY HENRY A. MAVOR.

(Concluded from page 360.)

It will now be clear that after all has been said which is to say on the theoretical considerations as to friction factor, angle of contact, working strain, ultimate strength of the belt, etc., that the most important elements in the question can only be decided by experience. We therefore now proceed to determine by this method what a good belt may be expected to do under a given set of circumstances, taking with us the approximate information obtained from preliminary investigations to enable us to predict qualitatively what will be the result of a variation in the circumstances. I have found that a single leather belt meeting the conditions enumerated will work for years at full load with so little stretch that it only requires taking up about once a year if it is worked according to the rule given by Messrs. Hoyt and Co. and some other first-class makers—viz., "1 h.p. per inch at 1,000ft. per minute," to which should be added, if the arc of contact be not less than 180deg. Referring now to our approximate formulæ we find that this gives the following values for the working conditions of a single belt 1in. wide, running at 1,000ft. per minute, and embracing half the circumference of the pulleys.

$$\mathrm{R} = 33\mathrm{lb.} = \mathrm{T}_1 - \mathrm{T}_2.$$

$$\log\frac{\mathrm{T}_1}{\mathrm{T}_2} = 2{\cdot}7288\,f\,n = 2{\cdot}7288 \times {\cdot}15 \times {\cdot}5 = {\cdot}20466.$$

$$\therefore \frac{\mathrm{T}_1}{\mathrm{T}_2} = e^{f\theta} = 1{\cdot}612.$$

$$\frac{\mathrm{T}_1 + \mathrm{T}_2}{2\,\mathrm{R}} = \frac{1{\cdot}6 + 1}{2\,(1{\cdot}6 - 1)} = 2{\cdot}1\dot{6}.$$

$$\begin{aligned}
\mathrm{T}_1 + \mathrm{T}_2 &= 2 \times 33 \times 2{\cdot}1\dot{6} = 142.\\
\mathrm{T}_1 - \mathrm{T}_2 &= \phantom{2 \times 33 \times 2{\cdot}1\dot{6} = 1}33.\\
\therefore 2\,\mathrm{T}_1 &= 175.\\
\mathrm{T}_1 &= 87{\cdot}5.\\
\mathrm{T}_2 &= 54{\cdot}5.
\end{aligned}$$

Or a working strain on the driving side of 87·5lb. per inch width. This then may be taken as the probable maximum working strain, calculated from the results of actual experience of the lasting power of the belt, and it may again be remarked that this bears no direct relation to the breaking strain—which is for the solid part of the belt 1,040lb., and for the cemented joint 842lb. per inch in width. It is much higher than the strain usually stated to be the working strain, because it is arrived at by deduction from an assumed ratio of the working tensions based on a friction factor much lower, and therefore surer for calculation than the figure usually adopted. Of course I do not suggest that these tensions are to be put on the belt, but only that allowance should be made for the tension reaching this amount. For double belts it is usual to calculate that they will stand 1¾ times the working strain of a single belt. It will now be seen how the preliminary conditions may be varied so as to vary the power transmissible by any given belt, assuming the friction factor as a constant. We can vary the arc of contact and the speed of running, and it of course follows that the greater the arc of contact and the higher the speed the more power may be transmitted by any given belt.

It should be borne in mind that to get satisfactory results from belt-drive, it is not best to leave the whole question to be settled by the belt. The pulley should be designed so as to give the belt the best chance possible to do its work. They should be large in diameter, because this gives high belt speed and increases the efficiency. Three thousand feet per minute is an easy speed for leather belts. They will run well at a speed of a mile a minute. They should be so placed and arranged that the arc of contact with the belt is as large as possible, because the ratio between the tensions approaches unity and their sum, and therefore the maximum strain on the belt is smaller the larger the arc of contact. They should be flat, not crowned, because crowning the pulley transversely strains the belt, and a good belt will run well without any necessity for this strain. They should not be flanged, because the flanges damage the edges of the belt and introduce useless friction, owing to different speeds at different diameters of the flange which may touch the belt as it enters or leaves the pulley. They should not be too far apart, because a belt does not transmit its working strain direct to the pulley when it is so long as to set up a swinging lateral motion. They should be turned smooth on the face, because a rough pulley tears the surface of the belt and produces destructive wear. They should be truly centred and balanced, because irregular motion of the pulley produces irregular strains in the belt which may exceed the regular proper working strain. They may with advantage be covered with leather, because the friction between leather and leather is greater than between leather and iron, and the belt will run with less tension on pulleys so treated. They should be placed with their centres as nearly horizontal as convenient, because vertical belts tend to sag off the lower pulley. They should be lined up truly parallel for simple drives, because if they are out of truth one edge of the belt will get most of the work to do. Wherever possible the slack or driven side of the belt should run uppermost, because the sagging slack upper side tends to increase the arc of contact with the pulley.

We may now devote a few words to the treatment of a belt when at work. I have not found it necessary to use anything at all in a good leather belt. A little castor oil, or the heavy mineral oil known as "post" oil, helps to keep the belt flexible in a warm place. Rosin, dubbin, and all sticky substances are fatal to belts. They rapidly destroy the surface of the belt and waste power by sticking it to the pulley. By accumulating in lumps or ridges on the surface of the pulley, they also strain the substance of the belt and lead to its destruction.

Single leather belts should not be used with belt forks to pass from an idle to a working pulley unless they can be run very slack, because otherwise they rapidly become twisted by unequal strain and give way by tearing. The best belts for this purpose are belts which are of a built structure, and run edgewise to the pulley.

All belts should be put on in the first instance by skilled workmen. As has been pointed out, the best belts are not those which will stand the greatest strain, and the best joints are not those which can be made by unskilled hands and rough-and-ready methods. New belts are often put on too tight, under the mistaken notion that allowance must be made for a great amount of stretching. A good belt will break with a stretch of only 3 per cent. A bad one may go on stretching indefinitely. A good belt put on askew is a good belt wasted. Too tight a belt wastes power in journal friction. Too slack a belt is apt to slip and waste power by rubbing the pulley. It is also liable to come off the pulleys altogether. The proper tension at which to put on a belt may be roughly stated to be that at which the belt when standing feels yielding, but firm and springy to the hand. If it feels like a drum head it is too tight. If it feels like a rein for driving a horse it is too slack.

If these latter remarks have a pedagogic ring about them it is due to an effort to compress them into as little space as possible, because I do not consider my opinions of sufficient authority to take up time by stating them at greater length, and I feel that I need to offer an apology for undertaking to bring before you a subject which after all, I know very little about. For information on this subject I am much indebted to my friend, Mr. Balderston, of Messrs. Hoyt and Co., now Fayerweather and Ladew; also to Messrs. Tullis and Co., and others, who have kindly supplied me with samples for experiment. I am also indebted to Mr. Carey and to the Steel Company of Scotland for facilities for making tests of tensile strength.

LEGAL INTELLIGENCE.

WOODHOUSE AND RAWSON UNITED, LIMITED.

The several petitions for the winding-up of this company came up for hearing on Tuesday and Wednesday before Mr. Justice Vaughan Williams, in the Chancery Division. The first petition was that of Miss Dora Langfield, Rochester, who asked for a compulsory winding-up order on the ground that the dividend paid had not been earned by the company. The other petitioners were from the Rate and Taxpayers' Association, Limited, Mr. John Tullis, and others, who appeared as creditors. After some discussion, it appeared that, with one exception, all the petitioners were willing to accept a supervision order, and the case was adjourned to the 29th inst.

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* Paper read before the Institution of Engineers and Shipbuilders in Scotland.

COMPANIES' MEETINGS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

The third ordinary general meeting was held yesterday at Winchester House, Old Broad-street, E.C., under the presidency of Sir David L. Salomons, Bart. (chairman). The Secretary (Mr. J. Cecil Bull) having read the notice convening the meeting, and the report and accounts having been taken as read,

The **Chairman** said that there were several resolutions to be shortly proposed, but he expected that the shareholders would first like to hear a little as to what was going on. He regarded every meeting of the Company as adding an additional chapter to its history. It was, after all, nothing more or less than a series of events which formed its history, which would no doubt be as remarkable in its way as many companies which had preceded them. Taking the first electric lighting company started—the London Electric Supply—they had their history, which the City Company and many others had utilised. The London Electric Supply had made many penalties in creating a history, and the City Company had tried to avoid those penalties. He had always told them that he intended to place before them all the information in their power, and he did not believe in keeping anything a mystery where such did not exist. There were, however, always negotiations proceeding which it was not wise to divulge until they were completed. At the recent meeting the set of accounts issued was criticised; they were incomplete and practically of little value, and gave a general idea of what was being done with the money. The Board of Trade had certain forms which they required to be filled up every year to December 31. The accounts presented to the shareholders had been made up according to those forms prescribed by Act of Parliament. As they knew, a report could not contain all that could be said in a few words, and he therefore intended to refer to the history down to the present time. Before proceeding further he would express great regret at the loss of a valuable colleague—namely, the late Duke of Marlborough—and he also regretted that the Hon. Alan Charteris, one of the directors who was absent from the previous meeting through illness, was still an invalid. Two of the directors—Mr. J. Bevan Braithwaite, jun., and Mr. F. W. Reynolds—were to retire and were eligible for re-election, and he would ask them to place those gentlemen in authority once more. Mr. Braithwaite was now chairman of the Brush Company, and he ventured to say that he took more interest in the City Company than in the former company. Mr. Reynolds had done them an immense service in many ways. The fact of Mr. Braithwaite being a director of the Brush Company, in the sight of many, might be considered as a disadvantage for him to be on this Board as well; but that was not the case, and the contractors had worked faithfully and done their best to serve the Company. The officers, which included the engineer and manager, secretary, engineer at the station, and numbers of others, had worked extremely hard for the interests of the Company. Coming to consider statistics, in the half-year ending December 31, 1892, and since the last meeting, £96,000 had been spent on capital account. The plant in position on the 31st December was sufficient to supply 37,500 8-c.p. lamps. The work done included 183,686 yards of ways laid in 24,810 yards of trench, and the cables reached a total of 32,455 yards of high-tension and 24,633 yards of low-tension cable. The public lighting absorbed £8,176 Now, down to 12th April, 1893, they were in this position. The total ways laid amounted to 427 miles, high-tension cables drawn in to 60½ miles, and low-tension 35½ miles. The number of lamps applied for during the six months ending December last was 21,000 of 8 c.p., and the number connected during that period was 8,400. The additional plant which was now down had enabled the Company to connect 18,000 lamps since the beginning of this year—that is to say, they had in the past three months doubled the number connected in the last half of 1892. The total number now connected was 38,200 lamps. It must be borne in mind that the supply of current had been a source of great anxiety, as the demand had been continuous, and they were still running off the pioneer station which the Company took over when formed. In order, however, to overcome some of their difficulties, they had ordered, and had now in position and at work, two large half-units, which each supplied 6,000 8-c.p. lamps. These were now assisting that station, so that a good deal of the trouble caused by people grumbling because they were not first supplied with light was being sobered down by degrees. These half units were driven by ropes, but the permanent machinery to be erected would all be direct driven. The Board had not been able to get the direct-driven machines in time to meet the demand; they had therefore made a contract with the Brush Company to the effect that when those two machines were not required any more, on the payment of a sum for depreciation they could be taken out again, and they would be replaced by direct-driven machines. There were some very large units on order from the Brush Company, and also from the Laing, Wharton, and Down Construction Syndicate. Of the two first large ones, which were in course of construction, the first was completed and had been tested at the works, when the machine ran very well. In about six weeks that large unit would be ready to run, and the second and third machines were already well advanced. These machines would supply current to about 14,000 8-c.p. lamps. The Laing, Wharton, and Down Syndicate were to supply two large machines, which were being made in America, and which they hoped shortly to receive. The Directors were making every endeavour so that by the end of the year they would be able to energise 130,000 lamps, if they proceeded as they were now doing. The great difficulties having now been surmounted, they would, no doubt, be able to fulfil what they now promised. After careful consideration the Board had come to the conclusion that it would be advisable to give up the station at Wool Quay as it would have been expensive to construct and maintain, and they were now removing to Bankside. The buildings there were being erected in sections, so that one section might be added as the demand for current increased. It was no use erecting a station four times larger than was required; it was much better to have their plant complete and develop it as they went along, because the number of lamps which would be required in the City would eventually be very large. One section of their buildings was practically complete and part in use, and the next section will shortly be built. He then drew attention to a plan of the buildings, the total length back from Bankside being 511ft., and also to curves showing how as soon as the lamps had increased in number the earning capacity had rapidly augmented. The time would not be long before the Company would be able to supply every place in the City and also Southwark. The latter was a small district, but they hoped before long to have that in the same condition as the City; the provisional order for it had only recently been obtained. No doubt the shareholders had seen the arc lamps in the City. As regarded the lesser streets, they were equipping two streets with incandescent lamps for the inspection of the Commissioners. Referring to the telephone tubes, he mentioned that when the Company was formed powers existed for laying any number of spare tubes. At that time the Company thought that Parliament would shortly be asked to grant facilities for laying telephone wires underground. They proved to be right, and shortly after that an Act came into force enabling electric light companies to lay tubes for telephone companies, or to lease any spare tubes, and they had, therefore, put down such tubes in the hopes of giving a good telephone service to the City. They had an informal agreement with the New Telephone Company in respect of those tubes, but the agreement could not be completed for another year, to draw in their wires without obtaining the consent of the Board of Trade, the Post Office, and the City Commissioners. So far, the consent of the latter had not been given, and therefore the tubes were lying idle. Any income which might accrue from those tubes would assist in bringing into operation a sliding scale for current, and any facilities which the Commissioners might give them would be beneficial to the people in the City. He hoped that the time would not be far distant before the Commissioners gave permission for the use of those tubes, but in the meantime they might not be aware that the overhead wires were being doubled, and that was a disgrace to London. After referring to the difficulty experienced in acquiring the whole of the land at Bankside from a number of owners, the Chairman said that the Directors suggested that as the Board of Trade required a special form of accounts once a year, it would be convenient for the Company to issue their accounts yearly in conformity with those forms. They would, however, hold half-yearly meetings. He then moved the adoption of the report and accounts.

Mr. J. Bevan Braithwaite, in seconding the motion, said that the progress made could hardly fail to be satisfactory to the shareholders. In dealing with the lighting of the City of London, they were undertaking a work which was the largest of its kind ever done by a company. He hoped that they would soon be able to cope with the demand. All through the career of the Company people had been coming to them asking for connections to the mains without the Company approaching them. He thought they might fairly look forward with every confidence to the future of the Company. The system adopted by them would give far better results than that of any other company, and would be the model for many cities and towns. He then seconded the motion.

In reply to questions, the **Chairman** said that each lamp earned about 14s. a year. As to the cause of the loss on public lighting, the City had a very favourable contract with them. The contract was for 21 years, but the City Commissioners could terminate it in seven years. It did not at all follow that because there was a loss now that there would always be a loss, and he thought it too early to answer a question of that kind.

The motion was then put and was adopted unanimously.

On the proposal of the **Chairman**, seconded by the **Earl of Suffolk and Berkshire**, Mr. J. Bevan Braithwaite and Mr. F. W. Reynolds were re-elected directors, and Messrs. W. H. Pannell and Co. were reappointed auditors.

A vote of thanks to the Directors brought the proceedings to a close.

WOODHOUSE AND RAWSON UNITED, LIMITED.

As trustees for the debenture stock of this Company, Sir Rawson W. Rawson and Mr. S. Pope, Q.C., convened by circular a meeting, which was held on Monday at the Cannon-street Hotel, of the stockholders and other creditors of this Company, to consider the present position and the course of action in the future. The circular calling the assembly mentioned that, apart from the appointment of Mr. Alex. Young as liquidator at the recent general meeting, petitions had been presented against the Company to wind it up compulsorily. Those petitions, it was pointed out, were to come on for hearing—and are referred to in another column—on the 11th inst., and it was important that the views of the creditors should be represented before the Court on the hearing of the petitions. That was the reason for convening the meeting on Monday, and to which reference is made below. The circular then proceeded as follows :

"Now that the liquidator has been appointed, the Directors have no responsibilty for the further management of the Company's affairs, but are desirous of a reconstruction scheme being carried out, which will not only save some of the shareholders' money, but will enable the creditors to be paid in full. The necessity of calling a meeting principally arises from the uncertainty as to the rights and priorities of the debenture-holders, and as to the value of the different portions of the assets charged to them, which may, in the event af the Company's assets being realised at break up prices by compulsory liquidation, be inadequate to discharge the mortgages upon them. On the one hand, it is suggested that a hasty and immediate realisation of the Company's assets, under a compulsory winding up, will probably result in a heavy loss even to the secured creditors, and, on the other hand, it is believed by many of those interested in the Company, that a reconstruction scheme may be carried through, which will not only pay all the creditors in full, but leave a substantial balance for the shareholders. We cannot give the details of the scheme, which is, we understand, at present before counsel, but we are able to say that the outline of the scheme is as follows : 1. That a new company be formed under a new board of directors, to be subsequently appointed by the subscribers as undermentioned, for the purpose of carrying on so much of the business of the old company as promises to be profitable, and constituting a channel through which the assets may be advantageously realised. 2. That the receiver of the Company's assets will not part with any of those assets to the new company proposed to be formed without receiving cash, or unquestionable security, to the value of the assets so to be transferred to the new company. 3. That any new money to be found as working capital for the new company shall not be subject to the liabilities of the old company. 4 That the sum of £25,000 be provided as working capital of the new company, this sum to be raised either from shareholders or from other persons outside the Company, who will receive as consideration for finding this money, bonds, or other securities, entitling them to a preferential claim upon the profits of the new company 5. The proceeds of the assets sold to the new company or others will be distributed by the receiver to the creditors of the old company according to their priorities. 6. The new company will assist the receiver in realising those assets of the old company which can be utilised in the business of the new company by the way of fulfilling their contracts, and in the ordinary course of trade. 7. Those portions of the Company's premises which are especially suitable for the trade which will be carried on by the new company will be leased to the new company." The circular concluded by stating that later on the reconstruction scheme would be laid in its entirety before the stockholders and others concerned.

Sir Rawson W. Rawson, who presided at the meeting, was supported by Mr. S. Pope and Mr. F. L. Rawson. After the Chairman had spoken on the contents of the circular, Mr. Pope, Mr. Stutchbury (manager), Mr. Leslie (receiver), and others addressed the assembly. The substance of their remarks was that under a compulsory winding up even the secured creditors would incur a heavy loss, and probably not get 10s. in the £, and that a scheme of reconstruction might be carried through which would not only pay the creditors in full, but also leave a balance for the shareholders. Generally, there was much said by stock and shareholders that has already been stated more than once at previous meetings, and it is scarcely necessary to reproduce the statements. The result of the proceedings was the adoption, with only one dissentient, of the following resolution :

"Resolved, that in the opinion of this meeting it is inadvisable that the Company should go into compulsory liquidation, but that Mr. Alex. Young, of Messrs. Turquand, Young, and Co., be retained as voluntary liquidator under the supervision of the Court with a view to carrying out a scheme of reconstruction."

A petition for presentation to the Court had in the course of the meeting been prepared, and was signed by various creditors at the close. The petition read as follows : "We, the undersigned, being creditors of the above Company, approving of its being wound up under the supervision of the Court, hereby authorise, but without charge to ourselves, Messrs. Slaughter and May, the solicitors for Mr. Alex. Young, the liquidator, who has been appointed by the shareheIders, to appear on our behalf in the hearing of the petitions which have been presented against this Company, and to support in our names the continuing of the winding-up of the Company under the supervision of the Court, and will oppose any order for the winding-up of the Company compulsorily."

The appointment of a committee of four persons to confer with the liquidator about the realisation of the assets of the Company concluded the proceedings.

HOBART TRAMWAYS COMPANY.

An extraordinary general meeting of this Company was held on the 6th inst at the offices, College-hill-chambers, E.C., under the presidency of Mr. Alfred Mattei, LL.D., to consider a resolution altering the name of the Company to the Hobart Electrical Tramway Company.

The **Chairman** expressed regret at the absence of the regular chairman of the Company (Sir Edward Braddon, the Agent-General for Tasmania). The proposed alteration in the name of the Company was, he said, made at the request of some of the largest shareholders, and the Directors, after careful enquiry, had found that they were well within their powers in acceding to the proposal. They had the advantage of having present at that meeting their engineer, Mr. Harper, who had been over the line and had expressed satisfaction at the manner in which the contract had been carried out. It was a matter of regret that the line had not yet been opened for traffic, but their Tasmanian friends were doing all in their power to accelerate matters.

In reply to a question, the **Chairman** stated that the Board were still in correspondence with the Tasmanian Government in reference to Sir Edward Braddon continuing to occupy the position of chairman of the Company, because it had been brought out under his auspices, and no one could better serve the interests of the shareholders than he.

A resolution in accordance with the object of the meeting was agreed to, and a vote of thanks to the chairman closed the proceedings.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY.

The second annual general meeting of this Company was held at the offices of the Company, Bournemouth, on Thursday, 30th ult., under the presidency of Mr. Aymor H. Sanderson, chairman.

The Secretary (Mr. Charles Offer) read the notice convening the meeting, the Directors' report and the statement of accounts being taken as read.

The **Chairman**, in moving the adoption of the report and accounts for the year ending December 31, said that the Directors considered they had every reason to be well satisfied with the progress made by the Company during the past year, and with the result of the year's business, showing a net profit of £327. 18s. 7d. It was particularly satisfactory to note that having separated the several items of revenue and expenditure for the two half-years, the Company's auditors have certified that a profit of £518 was made during the second half of the year. He did not think this profit was exceptional, but believed that the result of the present half-year's working would be equally favourable The development of the Company's business was specially marked during the latter half of 1892; the larger portion of the 3,438 lamps added during the year to the Company's mains were connected during that period, and some very important economies in administration expenses were then carried out, which could not fail to have due effect. The number of lamps connected at the date of the report (March 21) was equivalent to 9,350 lamps of 8 c p., and during the nine days which had since elapsed a further addition of 350 lamps have been connected, bringing the total number at that date to 9,700, which must convince the shareholders as to the rapidly-growing nature of the Company's business. The electric light was undoubtedly finding increased favour throughout Bournemouth, and applications were continually received from persons desiring to be supplied with the current in nearly every part of the town. A considerable demand for the light appeared to exist in the Holdenhurst-road and at the east end of the Knyveton-road ; it was probable that arrangements would be made for laying mains in those roads at an early date. The business of the Company was a difficult one to manage; they had to encounter obstacles and difficulties, and the undertaking would require a continuance of the steady perseverance of the Directors and officers which they had devoted to it in the past. The economies in administration expenses before alluded to had entailed additional work upon the Finance and General Purposes Committee of the Board and the chairman ; but the result had been most satisfactory. Careful attention had been given to the details of the business, and the system of management had been thoroughly overhauled and rearranged. It was hoped and believed that the station would be worked still more economically in the future, and would show further improvement as well as earn increased profits during the year 1893. Considerable additions and extensions had been made during the year to buildings, machinery, and plant at the lighting station. All of these had been maintained in an efficient condition, and the very tidy and clean appearance of the lighting station was especially noteworthy, and reflected great credit on Mr. James Shepherd, the works manager of the Company. This condition had been the subject of remark on more than one occasion when the station was visited by engineers and others accustomed to observe the state in which other electric lighting stations were kept. There had been entire freedom from accident of all kinds at this station since its establishment, which was highly satisfactory, and, of course, no reason existed why accidents should happen if proper care was taken. Many persons had an absurd fear of having the electric current in their houses, but there was no possibility of getting an electric shock from current as delivered to consumers' lamps in Bournemouth. He had read a paragraph in last week's *Electrical Engineer* to the effect that the deaths in England since the introduction of electricity for lighting purposes had only numbered six, and in every case they were of servants of the companies who made some mistake in dealing with the current. During the whole of that time not a single member of the public or a consumer had been killed or hurt With regard to the issue lately made by the Company of £10,000 6 per cent. first mortgage debentures, he was glad to inform the shareholders that £7,250 had been already applied for and allotted, and he had no doubt the remainder would be very soon taken up; these were actually mortgage debentures forming a first charge on the whole of the property of the Company, and they could not place any prior charge in front of them. In conclusion, he expressed great confidence in the future prospects of the Company—the business would doubtless continue to grow rapidly; the system of mains would have to be extended and enlarged as time went on to meet the requirements of the public. The capital account of the Company must necessarily bear the cost of these extensions. The working expenses, however, of each year would not increase in the same ratio as the yearly revenue would increase.

The Directors' report and accounts were then approved and adopted.

The retiring directors, Mr. G. J. Piercy and Mr. Leveson Scarth, were re-elected; Messrs. Cridland and Co., the Company's auditors, were also re-elected; and a vote of thanks to the chairman terminated the proceedings.

HASTINGS ELECTRIC LIGHT COMPANY.

The annual meeting of the Hastings and St. Leonards Electric Light Company was held on the 7th inst. Mr. H. M Baker, J.P. (chairman), presided.

The report and balance-sheet were taken as read. The former was as follows: "The Directors regret that some delay has taken place in issuing the report and balance-sheet for the past year, which is due to their having to wait for the accounts to be audited by the Board of Trade, in accordance with the provisional order. The sad death of the late engineer and manager, Mr. E. T. Mercer, is deeply regretted by the Directors, who had the highest opinion of the value of his services. He has left a widow and four young children unprovided for, and the Directors, feeling that the shareholders would desire to recognise the valuable services rendered to the Company by the late Mr. Mercer, propose to submit a resolution to vote the sum of £50 towards the fund being raised for the benefit of Mrs. Mercer and her family. The past year has been one of steady progress in the prosperity of the Company, and the additional machinery which has been provided, and which can be worked with greater economy of fuel, as well as the increase in the number of customers, must ensure satisfactory results in the future. The annexed accounts show that after paying all working expenses, and charging to that account repairs, interest on mortgage and debentures, there remains a net profit of £755. 8s. 2d., including the balance brought forward from the last account. The Directors propose to pay out of this sum a dividend of 5 per cent, which will absorb £569. 2s. 11d., leaving a balance of £186. 5s. 3d. Messrs. F. J. Parsons and F. Noakes retire from the directorate by rotation; they are eligible, and offer themselves for re-election. The auditors, Messrs. Hart Brothers, Tibbetts, and Co., also retire, and offer themselves for re-election.

The **Chairman** said they now had the best public and private lighting business of any provincial town in England, they had got machinery which was second to none, they were one of the best customers of the gas company, they had reduced their mortgage from £4,000 to £3,000, and their bankers were pleased to take 4 per cent. interest instead of 5. Last, but not least, by a curious coincidence he supposed that at that very moment the Town Council were confirming an agreement entered into by the Corporation with this Company for lighting the whole length of the front-line with electricity. After referring with regret to the death of their respected manager, Mr. Mercer, Mr. Baker proceeded to remark that their receipts for the last quarter of the past year were less than might fairly have been anticipated, but there was a state of general depression in the town, and the hotels, their principal customers, used less light. Then their expenditure increased by the fact that they introduced a large dynamo, which was capable of lighting three or four times the amount they did. However, he was pleased to tell them that since the commencement of the current year their increased consumption had been enormous, and with regard to the future, he took it they could do almost as much as they could possibly manage. They had applications in all directions, but it was a very difficult matter to carry mains to the extreme west of St. Leonards—on the hills, for instance. He begged to move the adoption of the report and balance-sheet.

Dr. Shorter seconded, and the motion was unanimously carried.

Mr. Baker then alluded to the suggestion in the report to vote the widow and family of the late Mr. Mercer the sum of £50, and in the course of some remarks on the value of their deceased manager, said that it had come to their knowledge that on more than one occasion a much more lucrative position had been offered to Mr. Mercer, but he told them he meant to remain with this Company, and look forward to the future to make up, by increased salary, for the time he spent with them in their younger days. Unfortunately, that prospect had been suddenly shattered. The two firms with which they largely dealt, the Brush Company and Glover and Co.—Mr. Edmonds, of the latter company, had stated to the directors that Mr. Mercer had never asked for nor received one single penny in the shape of fees for business done with them—had each promised 50 guineas towards the fund being raised for Mrs. Mercer and her four young children. The Directors suggested £50, but left it in the hands of the shareholders to say what amount should be voted by the Company to the fund.

The **Rev. J. W. Tottenham** said Mr. Mercer rendered most valuable services to them at a time when he could have received a far higher salary elsewhere, and he thought the widow and children had strong claims on them. He moved that they vote 75 guineas to the fund.

Dr. Campbell *seconded, and the proposition was carried.*

The retiring directors, Messrs. Parsons and Noakes, were re-elected. The auditors were also reappointed, and a vote of thanks was passed to the Chairman.

Mr. Baker, in acknowledgment, said he took it that the vote included his fellow Directors as well as himself. Alluding to a remark he had previously made in reference to the way in which the employés of the Company had worked when extra labour was entailed by the death of Mr. Mercer, he said that the three principal men (Mr. Ross, Mr. Geipel, and Mr. Burton) had been unremitting in their services to the Company.

EASTBOURNE ELECTRIC LIGHT COMPANY.

An ordinary general meeting of this Company was held at Eastbourne on Thursday last week. There were present the Mayor, Alderman Boulton (chairman of the Company), who presided, Mr. J. G. Langham, Alderman H. Sutton, and Councillor J. A. Skinner (directors); Alderman Keay, Mr. Caleb Diplock, Mr. F. Hollins, Mr. V. T. Sumfield, Mr. Wilkinson (manager), and Mr. H. Towner (secretary).

In their report, the Directors recommended payment of a dividend of 3 per cent. upon the subscribed share capital. They also announced that they had purchased the freehold of the works in Junction-road for £5,600. As it was in contemplation to extend the circuits to the Upperton district, it wonld be necessary to obtain additional capital, and a prospectus for this purpose would shortly be issued.

The **Chairman**, in moving the adoption of the report and balance-sheet, said he had met the shareholders many times, and many times he had done as the dog in the fair, carried his tail between his legs; but now he came round and showed them that this Company was progressing, and, what was especially satisfactory, that they were able to offer the shareholders a dividend. True, the dividend was not a large one, still it was one that was likely to increase. They had been fighting against prejudice, against antagonism, and against apathy for some years, and the fight against apathy had been the strongest of all. He had received a telegram that afternoon from Mr. Hammond, conveying the congratulations of that gentleman to the Directors and shareholders, and he (the chairman) also congratulated the Company generally on their present position and future prospects. He did not think that now there could be any doubt whatever as to the success of their Company. It might be interesting to give some few details relative to the business they were doing. The number of 10-c p. lamps fixed at that date was 7,667. They had on order 353 more, which made an aggregate of over 8,000. The number of lamps last quarter was 623, and the approximate value of installation work last quarter was £605. The extent of their circuits was represented by the following: No. 1, or arc circuit, three miles; No. 2, Queen's circuit, 2½ miles; No. 3, the Grand circuit, 4¼ miles; No. 4, Terminus-road circuit, ½ mile: making a total circuit of 10¼ miles. It was now proposed to move in the direction of Upperton. Residents of Upperton wanted the electric light, and would be only too glad to get it if they could have it. The expense of conveying it thither would be about £6,000, to obtain which the Directors must, of course, apply for fresh capital. He did not, however, wish to go into details of what would be, but preferred to talk to them of what was. They had fought through great difficulties, and now had the satisfaction of offering the shareholders a dividend which, although small, was some recognition of the enterprise they had displayed in investing their money, and was, moreover, an earnest of better things still in the future. He had no doubt whatever in his own mind that they would go on and before long pay the shareholders a dividend approximating to that of another company, which paid its 13 per cent. With respect to the other company, it must be remembered that its revenue was gathered from the whole town and from the service of the streets; whereas the electric light company was comparatively in its infancy, and, up to the present, had only done business over a limited area. The electric light company would yet give its shareholders a substantial return for their money, and the Directors, he was sure, thanked them for their long-sustained patience in the past. The shareholders had been 12 years without receiving anything, and he verily believed they would have placed such confidence in the Directors that they would have waited another 12 years.

Mr. Hollins: We could not help ourselves.

The **Chairman** said in any case the shareholders had sacrificed their time and money, and the Directors were happy in being able to offer them a dividend which bid fair to become a considerably larger one in the near future.

Mr. Langham, in seconding, said that Company was not instituted originally with a purely commercial motive, but with the hope of promoting the benefit of the town and advertising it effectually to the outside world. Commercial interests, although not foreign to the consideration of the shareholders, was certainly a secondary matter. Therefore they had none of them grumbled very much so long as they were effecting that primary object, the advance of Eastbourne, and they had been content to wait for a dividend until now. At the same time, the Directors could not forget the interests of the shareholders, and it was an immense satisfaction to find that, after sticking to the concern all these years, they had brought the Company to that state which allowed of a dividend being paid. No doubt the dividend was a small one, but dividends generally commenced in a small way, albeit 3 per cent. was not a bad rate of interest for money as securities went nowadays. In taking account of their position and prospects, they must bear in mind that all last year installations were going on, particularly in the wiring of houses, and that the houses wired between Michaelmas and Christmas could scarcely have been included in the accounts now before them. Those installations were going on now and producing income for the quarter just past, and he believed he was correct in saying that, notwithstanding the reduction in price from 10d. to 9d. per unit, their income would exceed that of the corresponding quarter of the previous year. Then what had they been doing this quarter ? In addition to the lamps running up to December 31, the installation work had amounted to £605, and that going on now was £260, making practically over £800 laid out this quarter. Consequently they might look forward confidently to paying an increased dividend at the end of the current year. Several things of interest had taken place. Amongst these had been the purchase of the freehold premises on which the works are carried on. That was an important step in the right direction, and he was pleased to say they were met by Mr. Gosden, the owner, in a very fair and generous spirit. Towards the outlay of the £5,600, they obtained £4,000 from the bank at 4 per cent., and Mr. Gosden had taken a mortgage for the remainder at 5 per cent. In doing this they were influenced by the fact that they had embarked a great amount of capital in the premises, in strengthening the foundations and generally adapting the place. One effect of the purchase was that they saved £110 a year in rent alone, and that of course would tell favourably on the dividend. Taking that circumstance into account, and also the fact that the business of the Company was increasing at a rapid rate, surely they might claim that the undertaking offered a sound investment, and that it was eminently worthy of public support. After showing from the engineer's monthly reports that the applications for fresh installations were constantly increasing, the speaker said nobody built a house now without making provision for the electric light. It was true, as Mr. Boulton had said, they wanted the light at Upperton, and his belief was it would pay very well to get it there. The fact that they had left Upperton out of calculation so long showed that the Directors, who principally lived in that district, had not considered their private wishes ; but he thought the time had come when Upperton should be served, and he did not think they need have any fears that the money would not be readily forthcoming. The £5,000 quoted by the Chairman as the probable outlay included the sum that would be needed for adding to their plant at the works, and he did not think he was unduly sanguine when he said he thought there ought to be no difficulty in getting a considerable amount of additional capital subscribed in Eastbourne.

Alderman Keay, in reference to the purchase of the works, asked whether the Directors had legal power to make a purchase of this description without consulting the shareholders?

The **Chairman** : It was always considered so.

Alderman Keay : I should like to know whence the power is derived, because I think any company that depends upon the public for support is more likely to succeed if the directors take the shareholders into their confidence.

The **Secretary** : The Directors certainly have the power.

Councillor Skinner : Besides which, the matter came before the last meeting of the shareholders. It was distinctly referred to, therefore the Directors did, I maintain, take the shareholders into their confidence.

The **Chairman** : You may take it for granted we should not have purchased if we had not had the power to do so. I think you may take it for granted we should not act outside our powers.

Alderman Keay : I have every confidence in the Directors of this Company ; but it seems to me strange that the directors of a company should have unlimited authority in a matter of this sort. We can well conceive that the affairs of some companies, unless they had got perfectly reliable directors, might get into a perfect mess.

The **Secretary** referred to the articles of association, and said these unquestionably warranted the Directors making the purchase referred to.

Alderman Keay said that was an answer to his question, which he only asked for information. He was surprised that directors had this power, and it was well known that when a railway or gas company wanted to do anything extraordinary they called a meeting of the shareholders and got their consent. He certainly did not know directors had unlimited power and could do what they liked. They found now that they had such unlimited power.

Mr. Langham : The shareholders knew the purchase was intended.

The motion was then put and carried.

Alderman Sutton then moved the reappointment of Alderman Boulton as a director, and said they might rely upon that gentleman doing his best for the Company. With respect to the previous discussion, it was perhaps well that the matter should be explained, but the shareholders might be certain that all the Directors had done had been for the benefit of the Company.

Alderman Keay said, to show he had every confidence in the Directors, he would second the proposition.

The motion was carried, and the **Chairman** briefly returned thanks.

On the motion of **Councillor Skinner**, seconded by **Alderman Sutton**, the auditors were re-elected.

Mr. Hollins said last year they voted the Directors a certain sum as remuneration in hope of prospective ability to pay. That hope had been realised, and he begged to propose that the Directors be paid £100 for their services during the past 12 months. The sum was small, and he did not think it should be taken as a precedent for succeeding years, any more than that the present dividend should be looked upon as all they were to expect in the future.

Mr. Sumfield seconded the motion, which was carried.

The **Chairman**, in highly complimentary terms, then moved a vote of thanks to the secretary (Mr. Towner) and the manager (Mr. Wilkinson) for the able manner in which they had conducted the business of the Company.

Mr. Langham seconded, and it was carried.

Mr. Wilkinson having briefly replied, the proceedings terminated.

BUSINESS NOTES.

Eccles.—The Eccles Town Council spend £50 in electrically lighting their Town Hall.

Nelson.—The Corporation of Nelson advertise for tenders for a battery of accumulators, to be sent in by the 25th inst.

Wolverhampton.—The Wolverhampton Town Council require an electrical engineer, at a salary not exceeding £300 a year.

Change of Address.—Mr. James Swinburne, consulting engineer, has changed his address to 4, Hatherley-road, Kew Gardens.

Bedford.—The Corporation of Bedford invite applications from companies or firms to carry out electric lighting under the provisional order.

Madrid.—The Director of Posts and Telegraphs of Madrid is inviting tenders, by 24th inst., for the establishment of a telephone exchange for the town of Haro.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,692.

Sales.—Persons having use for electrical material should see the notice *re* Messrs. Fowler, Lancaster, and Co., Limited, or the Birmingham Telegraph Factory, in our advertisement columns.

Aberdeen.—The Town Council are inviting tenders for water-tube boilers, high-speed engines, switchboard, etc., full particulars of which will be found on p. xvi. in our advertisement columns.

French Accumulators.—M. Paul Gadot, maker of the Faure-Sellon-Volckmer accumulators has taken M. Michel Pisca into partnership, and the firm will be known as Maison Paul Gadot et Michel Pisca.

National Telephone Company.—The Right Hon. Lord Balfour of Burleigh has joined the Board of the National Telephone Company, Limited, and will assume the position of vice-president of the Company.

Dundee Waterworks Telephone.—The Dundee Police Commissioners have established telephonic communication between the police office and the waterworks, for use in giving quick information in case of fire.

Powderhall.—The Edinburgh Cleaning and Lighting Committee have recommended the expenditure of £436 on an installation of electric lighting at Powderhall refuse depôt. The recommendation was adopted.

Darwen.—The Town Council of Darwen have decided that the new free library and reading-room should be illuminated with electric light, at an estimated cost of £700. Estimates for the necessary work have been invited from some six firms selected.

Canterbury.—The town clerk reported to the Canterbury City Council that the draft deed of transfer had been received ; the Brush Company had practically accepted the draft agreement. The town clerk had informed the company they were willing to sign.

Aberdeen.—The plans and specifications by Prof. Kennedy, London, as to the machinery and works in connection with the introduction of electric lighting in the central area of Aberdeen has been approved of. The scheme is estimated to cost £24,000.

Coalville.—At a capital entertainment of tableaux and vocal and instrumental music at Coalville the room was illuminated by the electric light, supplied by Messrs Hewes and Geary, of Coalville. The dynamo supplied 27 incandescent and two arc lamps of 2,000 c.p.

Reduction of Tariff.—The tariff by the Western Union Telegraph Company's cables and lines to the undermentioned countries in South America will be reduced as follows ; Rate per word *viâ* Galveston and Panama—Argentine, 5s. 9d.; Brazil, 5s. 9d.; Paraguay, 5s. 9d.; Uruguay, 5s. 9d.

City and South London Railway Company.—The receipts for the week ending April 9 were £842, against £742 for the corresponding period of last year, or an increase of £100. The total receipts for 1893 show an increase of £1,095 over those for the corresponding period of 1892.

Appointments.—Mr. William Henry Patchell, A.M.I.C.E., M.I.E.E., has been appointed chief engineer to the Electricity Supply Corporation, of the Strand, London. Mr. C. N. Russell, A.I.E.E., recently with Mr. Ronald Scott, has joined the London and Lancashire Electrical and General Engineering Company, of Dalston, N.E.

Indo-European Telegraph Company.—The Directors after adding £10,000 to the reserve fund, recommend a dividend for the six months ended 31st December, 1892, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. per year, and a bonus of £1 per share, making in all 10 per cent. for the year. A year ago the distribution was at the same rate.

Gas v. Electric Motors.—The Union Gesellschaft (Thomson-Houston), of Berlin, has made an offer to the Erfurt Municipality to construct an electric tramway in that town. On the other hand, the Dessau Gas Company has sent in a counter proposal, this being to work the line by means of gas motors, similar to those which have been tried experimentally in Dresden. A committee is considering the matter.

Preston.—Messrs. Horrockses, Crewdson, and Co., the extensive cotton spinners and manufacturers, have decided to introduce the electric light into two large weaving-sheds now being completed for them in that town, and also to illuminate in the same way a large spinning-mill they are about to erect on a site near by. Two of the firm's sheds are already fitted up with electric light, and the satisfactory results has led to the extension of the system.

Barnet.—At the meeting of the Barnet Local Board last week, Messrs Oldman, Clabburn, and Co. wrote to the clerk with reference to the electric light provisional order, saying that they had lodged with the Board of Trade copies of the order, and ask the clerk to write to the Board of Trade saying whether the Board had any observations to make on the order. If not, the order will be made a Bill. The Board agreed that the order pass into a Bill.

Domestic Telephone Company, Limited.—This Company has been registered by Ingram, Harrison, and Ingram, 67, Lincoln's-inn-fields, W.C, with a capital of £20,000 in £5 shares. Object: to enter into an agreement with Sir Charles S Forbes, Bart., and to carry on the business of a telephone exchange in all its branches. The first directors are Sir Charles S. Forbes, Bart., the Hon. James Mansfield, the Hon. Claude Hay, L. T. Fitzgibbon, and J. D. Croft. No qualification specified. Remuneration provided by deed of trust.

Edinburgh.—At the last meeting of the Electric Lighting Sub-Committee of Edinburgh Town Council, the question was discussed at some length whether the Corporation should themselves go on to put in force their electric lighting provisional order, or hand it over to a company. By eight votes to three it was resolved that the Corporation should take the matter in hand themselves, and this recommendation will be reported in due course at next meeting of the Lord Provost's Committee. We trust the proposal will be carried through.

Bradford Town Clock.—The peculiar contrivance which hangs in front of the south dial of the Bradford Town Hall clock, says the *Bradford Citizen*, is part of an experimental arrangement for the lighting of the face from outside. The cost of lighting the clock dials by means of gas was £200, and the new system of electric lighting entails an expenditure of £800. But if the experiment succeeds the price is estimated at only £137. The idea is to support a ring in front of each face bearing incandescent lamps (eight) with transparent reflectors.

Llangollen.—At the meeting of the Llangollen Local Board last week Mr Davies brought forward a motion in favour of taking steps to provide electric light for the town, and quoted several authorities in favour of the scheme. At the close of his speech he intimated that, owing to not having received the report of an eminent engineer upon a project of providing a scheme for the supply of electric light for public and private purposes, he was unable then to carry his motion any further. After some discussion, it was resolved to defer the matter for a month.

Southport.—The Town Council have adopted the recommendation of the Gas and Electric Lighting Committee to the effect that the whole question of electric lighting be referred to an expert to report upon, more particularly in regard to the system to be adopted and the position of the generating system. At the Council meeting on Tuesday night Councillor Hough said this course ought to have been adopted at the first, instead of sending deputations to various towns where electric lighting had been adopted. The only advantage gained, he added, was to make the members of the Council electricians.

Portsmouth.—At the last meeting of the Portsmouth Town Council, the Finance Committee reported that the Local Government Board had in accordance with the wish of the Council, intimated their readiness to issue an order authorising the creation of a 3 per cent. stock for the purpose of raising the money sanctioned for the electric lighting works and other purposes. On a report from the Electric Lighting Committee, it was decided that £500 should be paid to the contractor for the erection of the electric lighting station in Gunwharf-road, on a certificate from Messrs. Waller and Manville.

Leeds.—At the meeting of the Leeds City Council last week, Alderman Spark asked what steps had been taken towards obtaining electrical power for lighting the corporate buildings from the Yorkshire House-to House Company, in order to get rid of the nuisance caused by the engines and dynamos placed under the Municipal Buildings. Alderman Sir Edwin Gaunt said they had applied to the company named, but the company were not yet in a position to supply the electrical energy required. There were in the corporate buildings about 3,000 lamps, and the House-to-House Company were not in a position to light that number in all Leeds.

Aluminium.—The shareholders of the Société Electro-Metallurgique Française met on the 28th ult. to pass the 1892 accounts and pass resolutions for issuing 2,400 new shares, raising the capital from 1 300,000f. to 2,500,000f. The articles of association were modified to reduce the rights of founders. The company's aim is to diminish the cost price of aluminium as low as possible, so as to make this metal a common article of commerce. They have acquired new waterfalls at La Praz, near Modane, where a force of 20,000 h.p. is available. The new capital is to be employed in the construction of a factory to use part of this power. The sale price is 6f. per kilogramme (204d. per pound).

Private Lighting at Windsor.—A private electric lighting installation has been laid down by Mr. Badger, of Peascod-street, *who declined* to be deprived of the new light through the refusal *of the Corporation to give permission* to the lighting company to carry their main across the street. The Day's gas-engine and the "Taunton" dynamo for a time ran well, but the engine proved insufficient. Messrs. Day have replaced it by one of a later and an improved type. In this a twin-cylinder engine of 2 h.p. actual, both cylinders working, the one balances the other, steadier running is obtained. The dynamo remains unchanged. The new engine, which makes 400 revolutions a minute, has been running during the past few days, and so far has worked admirably. The cost of the light thus supplied to the two 100 c.p., six 16-c.p., and three 8-c.p. lamps is said to be a trifle less than 2d. per hour.

Lighting of Johannesburg.—Gas is sold here at 15s. per 1,000, coal costs £3 a ton, and electric light is supplied at we know not what, but both illuminants are furnished by the Johannesburg Lighting Company. A distinct preference, says Mr. Lane, the managing director, who is on the spot, is shown locally for the electric light. The plant now at work, and which energises nearly 2,000 lamps, comprises two 86-h.p. Babcock and Wilcox boilers, two 25-h.p. (nominal) engines, one 45-unit and one 30-unit Elwell-Parker alternators, one 10-unit Tyne alternator, and a 10-arc light Brush dynamo. A portion of this plant was first started a year ago, the remainder having since been added. Further extensions are in progress, a step which is not surprising when it is mentioned that the electric light is the popular illuminant in Johannesburg, and that it is at present impossible to meet the demands for light.

Oxford.—The Oxford General Purposes Committee, at the last meeting of the City Council, submitted a letter from the Oxford Electric Company, saying the company agree to make no charge for lighting the Carfax clock during the period of their contract with the Corporation for street-lighting, it being understood that the company only supply the current, and do not maintain the installation or supply renewal of lamps. The committee report that, as directed at the last Council, the engineer made a statement to the committee as to the paving works executed in connection with the laying of the electric cables, from which it appeared that the total cost up to the present time had been £862, of which a sum of £687 is repayable by the company to the Corporation, the remaining £175 being the half cost of the new paving material laid in places where the old material was in too bad a condition to relay, the other half being included in the above-stated £687, repayable by the company.

Electrolytic Copper Plant.—Mr. H. R. Caulfield, superintendent of the New England Copper Company, at Central Falls, Rhode Island, has just completed successfully a large electrolytic copper refinery for the Boston and Montana Company at Great Falls, Mont. The main building, which covers 300ft. by 525ft., contains 288 depositing vats, which are filled with 1 600,000lb. of pig copper in the shape of anodes. This plant is capable of turning out 1,200,000lb. of pure electrolytic copper per month. The current used is generated by two multipolar Thomson-Houston 125-kilowatt dynamos, and is transmitted from power-house to tankroom, a distance of 2,100ft., through 21 ½in. copper conductors. The total weight of copper conductor used is 55,000lb., and to line the tanks took 650,000lb. of lead sheet and pipe. The total cost, apart from site, was over £70,000. Heretofore the silver has not all been saved, but henceforth every pound of copper will be treated electrolytically.

Burnley.—At a meeting of the Electric Lighting Committee of the Burnley Town Council, it was stated that a sum of £800 a year would be required for interest and sinking fund on the amount already expended on the electric lighting scheme. It was decided that the price for the supply of electric light to consumers be 6d. per Board of Trade unit, and that the rent for meters hired by consumers be 10 per cent. on the first cost to the Corporation of the meter. Alderman Lancaster, replying to appeals to fix the rate at 5d. instead of 6d., said the committee could not afford to do this. They felt they were yet in the experimental stage, and they did not feel they could safely adopt a lower price until they had had some experience. A few of the charges in some of the leading towns would show the reasonableness of the price fixed on: Birmingham 8d., Brighton 7d., Dublin 7d., Glasgow 7d., Halifax 8d., Liverpool 7½d., Westminster 7d., Northampton 9d., Preston 7d., Southampton 10d., Hastings 9d.

Hastings.—The Lighting Committee reported at the last meeting of the Hastings Town Council that they had received from the secretary of the Hastings and St. Leonards Electric Light Company, a formal notice in accordance with the requirements of Section 14 of the company's provisional order, of the intention of the company to extend their mains for public lighting along the sea-front, from the Fish Market to the end of West Marina, as shown on the plans forwarded, and described in the notice, which received the approval of the Roads Committee, so far as the same came within their province, and the committee recommend that the formal approval of the Council be given to the work, as shown in the plans, as described in the said notice. This was agreed to. The town clerk reported that the contract with the Hastings and St. Leonards Electric Light Company, Limited, for the lighting, for a period of three years, of the front line from the Fish Market to West Marina, by means of 52 arc lamps, had been duly completed.

Blackpool.—At Tuesday's meeting of the Blackpool Town Council there was a short but interesting discussion regarding the price to be charged consumers of the electric light. The committee recommended the charge at 6d. per Board of Trade unit, with the following discounts for payment within 28 days: Quarter accounts up to £5, 5 per cent.; £5 to £10, 7½ per cent.; £10 to £20, 10 per cent.; £20 to £50, 15 per cent.; £50 to £100, 20 per cent.; and over £100, 25 per cent. In the course of the discussions it was stated that the electric lighting station was progressing satisfactorily, and the foundation-stone will be laid a week to-day by the mayor. Alderman Buckley took objection to the principle of giving larger discounts to large consumers, but Councillor Keay, in reply, pointed out that this course was necessary if they were to have the public companies in the town taking the light from the Corporation. It was also stated that the several public companies in the town had agreed to the terms arranged by the committee, and the minutes were confirmed.

Bank-Lighting.—The London and River Plate Bank have just moved into their new premises at Princes-street, where Messrs. Drake and Gorham have been engaged in reinstalling the old plant from their premises in Moorgate-street during the Easter holidays. The bank had carefully considered the question of obtaining their supply from the outside mains, but in view of the success with which the plant has been running for the last six years, they decided to shift the whole apparatus in preference to obtaining their current from the supply mains. No stoppage of the light was caused during the removal of the plant to the new premises, and it is found that the running of the engine is quite inaudible in any of the adjoining offices. Messrs. Drake and Gorham are also erecting an electric lift which will be worked off the accumulators. This will be of the same pattern as the one they put down some years back in the old premises, which has cost absolutely nothing for repairs since the day it was first installed, the working cost being considerably below the charges of the hydraulic company.

Grease Filter.—A filter for removing grease which often passes into the boilers with the feed-water, the invention of Mr J B. Edmiston, is manufactured by Messrs. Maudslay, Sons, and Field, of Lambeth. This filter consists of a metallic chamber or filter-box, in which are a series of gratings, and between these gratings are placed layers of wire gauze and flannel of a special texture, which forms the filtering medium. The feed-water from the donkey pump enters the filter-box on one side, passes upwards through the filter cloths, and thence out to the boiler, the scum passing away through another outlet. By this means it is found in practice that all grease and greasy matter, as well as other impurities, are arrested by the filter cloths, which can be readily taken out for cleansing or renewal. This filter is in use in a number of war vessels, Atlantic liners, and other steam vessels, representing an aggregate of 127,500 h.p. A special feature in this filter as used for engines up to 500 h.p is a by-pass valve invented by Mr. Walter B. Basset, director of Messrs. Maudslay's, which performs the functions of five valves which are necessary in the larger types. The filter is equally applicable to land as to marine boilers, and is a piece of apparatus that should commend itself to electrical engineers.

Traction in Calcutta.—No dividend is forthcoming for 1892 for the shareholders of the Calcutta Tramways Company, Limited, and at the general meeting on Tuesday, Mr. E. C. Morgan (chairman), mentioned, in reply to a question, that the company had constantly considered the question of electric haulage, but had found that it was too expensive. This statement was supported by Mr. Howard Vincent, who asserted that electric traction was 2d. per car mile higher than the system now in use, but he omitted to say what particular system was so much more costly. The expenses per car mile on the Calcutta lines, which are 19½ miles long, are given in the balance-sheet for last year as 8 04d. This is the average cost, and includes both haulage by horses and steam locomotives. There are, however, only 10 locomotives, whereas there are 180 cars and 1,030 horses, so that the average may be considered as applicable purely to horse-cars. In this case then, leaving storage-battery cars and conduit systems out of consideration, it is not easy to understand how the expenses of a trolley line would amount to 10d. per car mile run. There are doubtless various firms who would undertake the work at about half that figure At any rate the Madras electric tramways when once in operation may be able to give their Calcutta brethren a few points on the matter.

Eastern Extension, Australasia, and China Telegraph Company.—The report for the half-year ended December 31 states that the gross receipts (including Government subsidies) have amounted to £247,766, against £243,658. The working and other expenses (including £38,103 for cost of repairs to cables and expenses of ships) absorb £91,768, against £74,314, leaving a balance of £155,998, and an available balance of £188,343. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 20th instant, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 1 per cent., making a total distribution of 7 per cent. for the year 1892. The balance of £75,843 has been carried to the general reserve fund, which, after being credited with interests received on investments, now stands at £509,732. The alterations of tariff with the Australasian Colonies came into force on January 1 last, and the result so far is encouraging. Since the close of the half-year the tariffs at the stations affected by the serious depreciation in the silver currency have also been adjusted, so as to avert as far possible the loss on exchange from which the Company has so long suffered, and which during the past six months amounted to the large sum of £11,692.

Telephone Exchange at Swindon.—The movement for establishing an exchange in Swindon has been under consideration during the past five or six years. In 1887 an attempt was made by the Western Counties Telephone Company to open an exchange, but the matter fell through owing to the lack of subscribers, and only one or two wires being erected was the result of that attempt. It has been left to the National Telephone Company to bring the matter to a successful issue, and Wednesday last witnessed the opening of an exchange which will doubtless prove a boon to many persons engaged in various businesses in the town. The central office and switch-room is situated at the Public Offices, the most central position in the whole parish, and there is a public call-room at the Bell Hotel, Old Swindon. Though only just opened there are already 12 or 14 subscribers, and doubtless that number will soon be doubled or trebled The machine at present erected is fitted for some 60 subscribers, and the exchange is at present open from 9 a.m. to 7 p.m When experimented with at the switch-room on Wednesday afternoon by the chairmen of the Old and New Swindon Local Boards, the exchange worked most successful. The chairman of the Telephone Company, Mr. C. Nash, was present, and also Mr. H. Fedden (deputy chairman), Mr. Thomas A. Prout (district manager), Mr. H. G. Smith (engineer). The subscribers and a few other gentlemen interested in the movement were invited to the opening. It was stated that before long the charge would be reduced to £8 a year.

Watford.—At the Watford Local Board last week, the Clerk said he had been called upon to advise as to the position of the Board as regarded a letter which had been received from Messrs. Slatter and Co. with reference to an electric lighting company for Watford. Having read the letter, he read extracts from a pamphlet which had been prepared by Mr. J. A. McMullen, of London. It said that there was considerable danger to local authorities in allowing companies to start and have a monopoly. It recommended the authorities to obtain a provisional order themselves, and then they could either come to terms with a company or start themselves. The provisional order, if obtained by a company, would enforce that company to sell the plant to the local authorities at the expiration of a term not exceeding 42 years. He (the clerk) suggested the Board should interview Messrs. Slatter and Rogers and see how they intended to make it pay. Mr. Wilson thought the Board should have the control of the company and the money. The Clerk said they would have to get a provisional order. Mr. Wilson thought the Board should get the order. Mr. Benskin asked if they were obliged to do anything at once if they got a provisional order. The Clerk said they would either have to do something themselves or arrange with a company within two years. Mr. Andrews thought they would make a great mistake if they did not apply for a provisional order. The Clerk said he felt quite sure that if the Local Board asked for the provisional order no other application would be listened to. Mr. Andrews said if they got the order they need only take a few preliminary steps at present. They could do it cheaper than any company. Mr. Clifford said of course it would damage the gas company, as many people would prefer electricity to gas. He would pay three times as much and have electric light rather than gas. Mr. Andrews said he would give notice to move at the next meeting that the Board apply for a provisional order.

Birkenhead—At the meeting of the Birkenhead Town Council last week Alderman Deakin referred at considerable length to the question of the introduction of the electric light into the borough, and submitted a report by the Finance Sub-Committee on the subject. The committee adopted the report, and recommended the Council to carry out the provisions of the Birkenhead Electric Lighting Order, 1890. Unless the Council itself, the report stated, proceeded to carry out the provisions of the order, and put itself in a position to supply electricity within the borough without undue delay, in all probability the Board of Trade would withdraw from them the powers which they now possessed. It was most likely that the powers would be conferred upon some company which would be prepared to supply electricity to the exclusion of the Corporation, probably for a period of 42 years. In the course of his remarks, Alderman Deakin said that when first they began to consider the question very little was known about electric lighting, and it was looked upon as a risky undertaking, requiring a considerable amount of capital, and, therefore, the inclination was not to recommend the Council to embark their own capital in the enterprise. After consideration, however, they came to the conclusion that under any circumstances there would be considerable disadvantage to the Corporation in parting with their order, even under an agreement with a company. In the first place, they would retain the full control of the streets, and, secondly, they would guard against any undue competition with their own gasworks. In the next place, they had been informed by representatives of electric lighting companies that a corporation owning a gasworks could work a concern more cheaply than they could otherwise. They could also lay down solid and permanent plant, such as a temporary company were hardly likely to do, and they would then be in a position to retain in their own hands any benefit that might be derived from fresh inventions. They had a reasonable hope that after the first year the concern would be self-supporting, and after that might become profitable. It was necessary to come to a decision at once, as unless they did so they would forfeit the order altogether. Replying to Mr. Gamlin, Alderman Deakin said a small installation for the purpose of supplying a portion of the borough might be instituted for about £10,000, but the Corporation would not go further until the demand increased. Alderman Deakin then moved a resolution that the Finance Committee proceed to carry out the provisions of the Birkenhead Electric Lighting Order, 1890, with power to call in experts, engineers, and advisers. This was approved.

Elmore's French Patent Copper Depositing Company.—The following circular letter has been issued to the shareholders: "Herewith we beg to send you accounts made up to December 31 last. From these you will see that the total amount of working capital that the Company have had at their disposal at the date of the balance-sheet from shares and debentures, after paying for patents, has been £140,061. In addition to this, the Company have had upon second mortgage £39,353, and from loans the sum of £28.789, and have incurred further liabilities amounting to £21,761. This sum has been expended as follows: 1. Cost of land, buildings, plant, furniture, stock, cash in hand, and other assets, £169,458. 2. Expenses of issue of preference capital, £3,384, which would, in the ordinary course, be spread over a series of years. 3. Expenses up to May 31, 1892, connected with the establishment of the Company, the working out in the laboratory and works of the details of the process and alterations connected therewith, and in connection with the new patents taken out by the Company, £18,483, the major portion of which could be either put to capital account or the whole extended over a series of years. 4. Administration charges in Paris and London up to May 31, 1892, which might be spread over a term of years, but which it would be more prudent to write off at once—namely, £14,416. 5. The amount paid by the Company as interest and commission, £4,165, after deducting interest received on deposits, £609, which must be written off. 6. With regard to the bonus credited—but not yet paid—to the foreign company—namely, £3,000, this the Directors hope will be waived. 7. The remaining items for rent of water power and loss by exchange on sending money to Paris amount to £4,256. The profit and loss is taken from June 1 to December 31, 1892, which is the time that the Company has been at work regularly. It may be recollected that Sir Frederick Bramwell and Mr. Harris estimated that 12½ tons per week would pay all expenses. Owing to the small output during this period—namely, about seven tons per week—the loss in manufacturing amounts to £5,187. Of this there is a certain amount of copper existent in the furnace bottoms, which is recoverable when these furnaces are ultimately taken up, though in the accounts treated as loss. The total administration expenses in France during this period amounted to £2,972, and in London to £2 427. These charges are increased beyond the normal by incidental expenditure and professional charges, travelling expenses, etc. The amount of interest and commission comes to £4,884 for the same period, whilst the interest on debentures comes to £1,750, and the rent of water power at Bellegarde to £1,687. The Directors consider that in normal working the administration charges in Paris and London ought to be covered by £5,000 per annum, unless the business is carried on on a much larger scale than is proposed. Naturally, at the outset of the Company heavy expenses have had to be incurred under this head.—By order of the Board, J. SHURMER, secretary."

PROVISIONAL PATENTS, 1893.

APRIL 1.

6800. **Improvements in or appertaining to electric lighting apparatus or plant for railway trains, tramcars, or other like vehicles.** Thomas John Flynn, 6, Lord-street, Liverpool.

6805. **A new shade for lamps or candles, especially suitable for incandescent electric lamps.** Edwin William Streeter, 61, Chancery-lane, London. (Complete specification.)

6813. **Improvements in electrical arc lamps.** Frank Bryan, 11, Brackley-terrace, Chiswick, London.

6885. **Improvements relating to electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Michel Angelo Cattori, Italy.) (Complete specification.)

6886. **Improvements relating to commutator switches for use in charging electric accumulators.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Carl Liebenow, Germany.)

APRIL 4.

6921. **Magneto-electric generator with fixed armature.** Tito Rosati, 52, Chancery-lane, London.

6922. **Devices for electrically heating crucibles and other articles.** Willis Mitchell, 77, Colmore-row, Birmingham. (Complete specification.)

6933. **Improvements in or relating to the working of signals and locking of points electrically at railway junctions.** The Automatic Electric Railway Signal Company, Limited, and Edwin Blakey, 78, Fleet-street, London.

6935. **Improvements in meters or apparatus for making measurement of electrical energy.** Alfred George Brookes, 55, Chancery-lane, London. (Herbert Clarence Wirt, United States.)

6952. **Improvements in electrically-heated crucibles and holders therefor.** Willis Mitchell, 36, Chancery-lane, London. (Complete specification.)

6954. **Improvements in the construction of primary elements for producing electrical currents by the moisture and heat of the human body or by separate excitation.** Alfred James Jarman, 75, Ramsden-road, Balham, London.

6965. **Improvements in and relating to electric furnaces** Rudolf Urbanitzky and August Fellner, 45, Southampton-buildings, Chancery-lane, London.

6975. **Improvements in or connected with apparatus for periodically completing and interrupting electric circuits.** *Ernest Lower Berry* and Frederick Harrison, 47, Lincoln's-*inn-fields, London,*

APRIL 5.

7005. **An improved electric accumulator plate.** Reginald Frederick Yorke, 45, Holborn-viaduct, London.

7020. **Improvements in the construction of electromagnets and in their application to electromotors, and apparatus for use with alternating currents.** John Augustine Kingdon, 29, Marlborough-hill, London.

APRIL 6.

7069. **A new method of fitting telephone instruments.** Arthur Ernest Field, 3, King's-road, Southsea, Hampshire.

7082. **Improvements in flexible brackets for electric lighting and other purposes.** Frederick William Ketley, 17B, Great George-street, Westminster, London.

7085. **Improved apparatus for producing intermittent electric flash-light signals or messages by the Morse or kindred codes.** Owen Edleston Wheeler, 22, Glasshouse-street, Regent-street, London.

7101. **Improvements in apparatus for use in connection with electrical transformers.** Francis Hastings Medhurst and William John Hope Johnstone, 70, Chancery-lane, London.

APRIL 7.

7190. **Improvements in the manufacture of the magnetic parts of electrical apparatus** Anthony George New, Palace-chambers, Westminster, London.

7192. **Improvements in guards for electric and other lamps.** James Eaton-Shore, 77, Chancery-lane, London.

7194. **Improvements in vehicles running on rails, applicable to electric traction and for other purposes, and adapted to pass around curves.** Georges Averly, 77, Chancery-lane, London.

7199. **Improvements in portable electric lamp apparatus.** Sante Hellebrandt, 18, Buckingham-street, Strand, London.

7213. **Improvements in the manufacture of concentric electric conductors.** John Smith Raworth and Thomas Octavius Callender, 46, Lincoln's-inn-fields, London.

APRIL 8

7246 **Improvements in material for conveying electrical currents to the human body.** Henry Nehmer, 14, Grafton-street, Gower-street, London.

7266. **Improvements in the distribution of electrical energy.** James Whitcher, 14, Orde Hall-street, Bloomsbury, London.

SPECIFICATIONS PUBLISHED.

1892.

1041. **Generating electricity for buildings.** Rollason.
5579. **Incandescent electric lamps.** Swinburne.
5712. **Telephones.** Anders and Köttgen.
6015. **Incandescent electric lamps.** Harper.
7004. **Electrical cooking apparatus.** Wallace.
7142. **Incandescent electric lamps.** Krüger.
8196. **Arc-light poles.** Deakin and Spence.
8556. **Alternating-current electric machinery.** Patin.
8854. **Electric-light fittings.** Smallwood.
8986. **Electric cables.** Rylands.
9486. **Overhead system of electric traction.** Dickinson.
14096. **Electric arc lamps.** Church.
21794. **Electrodes for ozonisers.** Andreoli.
23361. **Teaching telegraphy, etc.** Heil
23501. **Electrically playing stringed instruments.** Lake. (Vose.)

1893.

724. **Incandescent electric lamps.** Pope.
1057. **Electric railways.** Lake. (Harris.)
1077. **Electric telephone apparatus.** Thompson. (Lesenberg.)
2059. **Telegraphy.** Heil.
2455. **Electric arc lamps.** Jergle.
2625. **Car couplings.** Barker. (La Burt Electric Block Signal System and Car Coupler Company.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	5⅞
	3	4⅛
London Electric Supply	5	1½
Metropolitan Electric Supply	—	7½
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

World's Fair.—The Chicago Exhibition will be opened at the beginning of May.

Institution.—The discussion on Mr. Albion T. Snell's paper on "The Distribution of Power by Alternate-Current Motors," will be resumed on the 27th inst.

Havre.—The town of Havre is to have an electric tramway. The Société l'Energie Electrique of this town have decided to have the station erected on the Thomson-Houston system.

Schuckerts. — The firm of Schuckert and Co., of Nuremberg, has been formed into a limited company. They have immense works, one of the largest in Germany, employing something like 2,000 men.

Copper in Damaraland.—The mining engineers of the South-West Africa Company announce the discovery in the company's territory of an extensive outcrop of copper ore near the Otavi mines, in Damaraland.

Cheap Electricity.—The Berlin Electricity Company, at its central stations with a capacity of 200,000 16-c.p. lamp, now sells its current for motors at 20pf. (2½d.) per kilowatt-hour. The price for lighting is 3½pf. (·4d.) per 8-c.p. lamp per hour.

Blackpool.—The foundation-stone of the new electric lighting station is to be laid by the Mayor to-morrow (Saturday), April 22. His worship has issued invitations to the members of the Council and others to dine with him at the Palatine Hotel after the ceremony.

Street Leakage.—A short circuit occurred between a street-car standard and a gas lamp in Indianopolis recently, when a hole was melted in the lead pipe and the issuing gas blazed 15ft. high. This is a danger street railway engineers will have very carefully to guard against.

"Glow" Lamps.—"The feeling is now undisguised," says the *Electrical World*, "that the time is not far distant when the filament lamp as a source of light will be relegated to the past and obsolete, and the glow-worm in mechanical simile will take the place of the less efficient carbon."

Theory of Transformers.—Profs. Bedell and Crehore, whose book on "Alternating-Current Theory" has just been published in this country, have a set of articles dealing mathematically with the "Theory of the Transformer" in the *Electrical World*, March 25 and April 8, to be followed by others.

Royal Institution.—To-night, at the Royal Institution, there will be a very interesting discourse by Prof. Alex. B. W. Kennedy on "Possible and Impossible Economies in the Utilisation of Energy." On Saturday, at 3 p.m., Mr. Swinburne will lecture on "Applications of Electricity to Chemistry."

Vienna.— A number of electrical specialists were recently appointed to study the question of the application of electric traction to the tramways in Vienna. The commission have visited the celebrated central open-slot tramway in Budapest to enquire into the working, with a view to the adoption of the system in Vienna.

Lecture at Hove.—Mr. R. E. Crompton gave an interesting lecture on Tuesday evening last week, at the Hove Town Hall, on electricity and its modern development popularly described, particularly in its application to dwellings. There was a large audience and the lecture was illustrated by experiments. Mr. J. Woodman, chairman of the Electric Lighting Committee of the Hove Commissioners, presided.

Institution of Mining.—At the Institution of Mining and Metallurgy, on Wednesday, Mr. Arthur L. Pearse read a paper on "Mining in Peru." This is one of the countries where mining processes are likely to be changed by the introduction of electric appliances, actuated by the water power from mountain torrents. The countries surrounding the Andes will, in the future, be as rich from their power stores as Switzerland and Italy are beginning to feel themselves.

Gas or Electric Traction.—The Thomson-Houston Union Company, of Berlin, are proposing to the Erfurt Municipality to erect an electric tramway on the overhead wire system. The Dessau Gas Company propose to run gas-motor trams on this line; and there is likely to be a considerable struggle of interests to obtain the coveted concession. Experiments at Dresden, it is stated, have recently satisfactorily demonstrated the success of gas-motors to tramcar traction.

Electro-Tanning.—Dr. Rideal has a note in *Industries* last week on Mr. Falkenstein's electro-tanning experiments, which he does not regard as so satisfactory as those of his own. There seems no reason, he says, why the phlobaphene should not be recovered as suggested by Mr. Falkenstein; but "the fact that shumac and other tannins yielding much 'bloom' also give a greater precipitate when current is passed through their solutions, indicates that such tannins should be avoided in electrical work."

Engineer Apprentices.—A correspondent wishes to know, with reference to a note last week on engineer apprentices in the service of the Indian Government, where he should apply to in order to obtain such a place, as all the large and reliable firms require too much money. We can only suggest that application should be made at the offices of the Indian Government; or to the office of the *Indian Engineer*, 1 and 2, Victoria-mansions, Victoria-street, Westminster, where information might be obtained.

An Aerolite of an Unknown Metal.—The New York correspondent of the *Standard* says that Prof. Joplin, the assayer to the Federal Government, who is attached to the Missouri Mineralogical School, has analysed the aerolite "from the direction of the constellation Perseus," which recently struck the John Brown statue. Electric fusion disclosed that 25 per cent. consisted of an unknown metal, with lines in the spectrum which are assigned to the hypothetical element peculiar to the sun, to which the name of helium has been given.

Electrolysis by Alternating Currents.—Signor Ricardo Malagoli (announces the *Bulletin de l'Electricité*) has established that the necessary and sufficient condition under which the phenomenon of electrolysis by alternating currents is possible, is that the quantity of electricity which traverses the voltameter during a single alternation of current is greater than double that which is required to produce the maximum polarisation in the voltameter. The electrolytic production ceases when these two quantities are equal, and the quantity of electrolyte decomposed is proportional to the difference of these two quantities.

Feeder Patent.—An important decision has been given in the American Courts, though no details are yet to hand. It relates to the Edison feeder patent. The Court has ruled in favour of the Edison Company against Westinghouse, Church, Kerr and Company. The patent relates to the method of equalising pressure through an entire system by feeders to prevent drop of voltage at distant points. The General Electric Company claim that the patent gives them absolute control over all present methods of distributing current over large areas for light and power by the constantbiography have probably seen the epitaph, written by himself, likening his body, in printer's phrase, to an old book which will be reprinted and rebound hereafter in "a new edition by the Author." This pretty epitaph is not on the tomb, however—a simple name and date records his death in 1790. But while erecting a new tomb, it would be a graceful act to place on it the celebrated epitaph. A fund is being raised, and many English electrical men might like to send subscriptions. These will be received by Mr. G. Wilfrid Pearce, New Jersey Lamp Works, New Brunswick, or by Mr. W. H. Johnson, secretary to the Edison Electric Light Company, Philadelphia. Let it no more be said of Franklin's grave: "In this *neglected* spot is laid a heart once pregnant with celestial fire." Few spots of ground are better worth reverence from electrical engineers.

Technical Instruction.—At the Manchester City Council meeting last Friday, a resolution was moved by Mr. Hoy for the adoption of a resolution passed by the Technical Instruction Committee, proposing to advance the salaries of Mr. H. G. Jordan, chief lecturer on engineering, from £300 to £350 per annum; Mr. T. Fox, chief lecturer on textiles, from £250 to £300; Mr. R. Trainor, instructor in woodworking, from £200 to £225; Mr. W. H. Davies, practical instructor in engineering, from £185 to £200; and Mr. S. Joyce, second lecturer in electrical engineering, from £150 to £200. Mr. Hoy said he wished to enlist the sympathy of the Council in the work of the technical school, and to point out to them that the teachers at their technical school were the authors of some of the best known text-books on technical instruction in the country. Manchester ought to be proud of those teachers, and support them as men who were exceedingly well qualified to teach the various subjects in which they excelled. The resolution was seconded by Mr. Rawson, who said the Manchester Technical School already had 3,127 pupils, and was the largest of its kind in the United Kingdom. It had a staff of 85 teachers, and it held the very first position among the schools of its kind in the country.

Ostend.—It is thought likely that Ostend will be lighted by electricity for the coming season. The Communal Council have received an advantageous proposition from M. Moris, who offers to take over the gasworks at a price higher than their present value and to pay immediately. He would then lower the price of gas, and organise a system of distribution of electric light and power. The water from the communal canal would be used. The electricity would be charged at 9½d. per trade unit (10c. per 100 watt-hours), with 25 per cent. reduction to the town. M. Moris would further pay for 10 years a royalty of £400, which, after the eleventh year, increases £40 a year to the twenty-first year, and afterwards £52 a year until it reaches £1,600 a year at the thirty-third year—the term of the proposed concession. The town will have the right to buy up the installation at any time after the tenth year, by refunding the capital, on condition of paying the average profits of the first 10 years until the end of the concession. It is expected that the Council will accept this very fair offer, especially as the gas lighting has proved troublesome and not very lucrative. They will get rid of their gas, obtain a good lighting system, good royalties, and at the end of 32 years they will become possessed of a central station without having paid a penny.

Specification Competition.—A new plan has been developed by the Corporation of Winchester. Hitherto the different methods of obtaining electric lighting projects have been to engage an expert, or to invite companies to send in schemes and estimates. The engagement of experts has been known to fail through the committee having strings pulled, or not knowing where to obtain a really suitable electrical engineer. The method of invitation of estimates and projects indiscriminately from firms and companies we have always set our face against—it does not seem the right way to ask business men to spend valuable time, and make drawings and estimates, for a problematical order. But there is a third way—sometimes adopted in architectural competitions—of inviting plans and offering a premium for the best set. Those who can spare time and are willing can enter for this competition, and may obtain a suitable reward; and the business firms do not feel they must needs enter, as they will be assured occasion for tendering when the selected plan is adopted and the tenders are invited. The plan gives trouble to a number of persons; but they need not enter unless they like, and it has the advantage of giving younger and unknown men an equal, or almost equal chance with the best consulting engineer, and a position is sometimes made from a single competition of this kind.

Edinburgh.—The following memorial against the Edinburgh Town Council working the electric light order themselves has been largely signed by the Princes'-street and other shopkeepers, and presented to the Town Council: "We, the undersigned citizens of Edinburgh, observing that the Lord Provost's Committee have decided to recommend the Town Council to take into their own hands the lighting of the city by electricity, humbly desire to express our conviction that such a course would be against the best interests of the city, looking to the fact that there is a thoroughly substantial local company willing to take the initiative risk. Some of the advantages which the citizens as a whole would derive, should the Town Council delegate the electric lighting to a local company, would be as follows: (1) None of the citizens who are not consumers would be taxed for the introduction of this new illuminant; (2) a company is in a better position to carry through the undertaking more satisfactorily than the Town Council, seeing that the members of the latter are already overtasked; (3) a company would be more popular with all classes of the community, and consequently would be able to secure a very much larger number of consumers." It is somewhat inexplicable that the capitals—London, Dublin, Edinburgh—cannot make up their capitalistic minds to own their own central stations—evidently the proper way, under proper management. Smaller towns—Portsmouth, Larne, Dundee—can do it; so also, we think, should the larger, and especially the capital towns.

Chamber of Commerce.—During the year the Electrical Trades Section of the London Chamber of Commerce (says the annual report) has held three meetings, in addition to a considerable number of meetings of special committees appointed to deal with various subjects. One of the most important matters dealt with was the County Council by-laws for the regulation of overhead wires under the Act of 1891. A special committee was appointed to take what action might seem necessary in regard to the by-laws, and as a result a petition was prepared and sent to the President of the Board of Trade pointing out the impracticable nature of many of the proposed by-laws. This was followed up by a deputation to Sir Courtenay Boyle, at the Board of Trade, and it is satisfactory to state that the by-laws were ultimately settled to the general satisfaction of the industry. An attempt was made to organise a representative electrical exhibit for the Chicago Exhibition, but as the suggestion did not meet with sufficient support, the matter was allowed to drop. A special committee was also appointed to consider the possibility of reconciling the rival claims of the traction and telephone companies as to the "use of earth." A number of gentlemen were appointed arbitrators to act in the settlement of any disputes arising in the trade under the rules and regulations of the London Chamber of Arbitration. The section has agreed to follow the precedent of other sections by abolishing its Standing Committee, and convening the whole of the membership to all future meetings. Other questions discussed included the relation of the Association for the Protection of Telephone Subscribers to the Chamber, electrical communication on the coasts, merchandise marks, standardising of electrical machinery, and uniformity of prices.

Board of Trade.—The Board of Trade has just issued the following modification to hitherto existing regulations: "Whereas in certain regulations made by the Board of Trade under the Electric Lighting Acts, and certain provisional orders and licenses granted under those Acts, it is provided that where the supply of energy is transformed at a converting station, some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure distributing mains shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with or leakage from the high-pressure system either within or without the converting station; and whereas under such regulations it is also provided that where any transforming apparatus is installed on a consumer's premises, some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure service lines and consumer's wires shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with or leakage from the high-pressure system either within or without the transformer: now, therefore, the Board of Trade approve of the following arrangement for use in any case where a high-pressure supply of energy is converted to a low-pressure supply by alternating-current transforming apparatus, as a means of preventing contact between the high and low pressure conductors within such transforming apparatus—viz., an arrangement such that by the construction and winding of the apparatus any wire or other conductor forming part of the low-pressure supply circuit within the transforming apparatus, is separated from any wire or other conductor forming part of the high-pressure supply circuit within the transforming apparatus in every part by a wire or other conductor possessing sufficient sectional area which is efficiently connected to earth, but is not in metallic connection with either the high-pressure or low-pressure supply circuits."

Clifton Rocks Railway.—A very perfect system of signalling by means of electricity is in use on this railway. It has been especially designed for the purpose by Messrs. King, Mendham, and Co., electrical engineers, Western Electrical Works, Bristol, and erected by them. Water is the motive power used for hauling up the cars; these may have any number of passengers up to 18, and a like number or fewer may be in the upper car; provided there be more wishing to descend than ascend, that state of things may be sufficient to establish a means of working the system, but if the weight on each car be equal or nearly so, then so much water is admitted into a tank on the upper car till it overbalances the lower one and it begins to descend, hauling up the other car. In order, then, that the engineer at the top shall know the load (extra to his passengers) that is required to overbalance the lower car, it is necessary for him to know the number of passengers coming up. This is accomplished by an ingenious arrangement of contact, by which the conductor of a car is enabled to signal up as the car fills the number of passengers entering. These signals are received one after another upon a signal-board on each side of the engineer, an electric bell ringing at each fresh indication of additional passengers. When the car is ready to start the conductor signals accordingly, by means of a special contact, which signal is likewise received upon the board. The engineer knows by gauge on the car at his end when enough water has been admitted into the tank to take the car down, and when he is ready a signal is sent down to an electric bell that the car is starting; a local buzzer is inserted in the circuit, by the sound of which it is known that the distant bell is ringing, and the indicators are reset in the act of transmitting the "starting" signal, so that the apparatus is in perfect readiness for the next journey. Separate electrical contact and indicator-boards are provided for each set of cars, and a double set of batteries to ensure the proper working of the whole system, and to obviate all risk of a breakdown. Immediately a car reaches the lower end of the tunnel the water in its tank is automatically discharged into a large reservoir: this water as it accumulates is pumped up to the top, and its varying height is known at the bottom by means of an electric water-level indicator, which shows on a dial differences of 3in. of level either way.

Frequency in Transformers.—With reference to this subject, *Industries* says: "Some years ago there was a very unprofitable discussion as to the relation between the dimensions and output of a dynamo. Professors multiplied the linear dimensions of phantom dynamos by *n*, and found the output was various fractional powers of *n* times that of the original phantom before they had tampered with it. The discrepancies were numerous, but they were all due to electricians assuming different conditions. The dynamos might be compared if designed so as to give the same efficiency, or the same final temperature. The copper might be run at the same current density, or the magnets at the same induction. If the same induction were employed, the armature of the larger machine, when enlarged to scale, had too many ampere-turns, and so on. Then, again, the larger machine could not reasonably be expected to run at the same speed, so it had to go either with the same factor of safety or the same peripheral speed. Hence there were so many ways of comparing the machines that the results of the calculations did not agree. We are now threatened with a similar pseudo-scientific epidemic with regard to transformers and frequencies. Mr. Steinmetz calculates that the output of a transformer varies as the three-eighth power of the frequency. Obviously, if a transformer of a given size is to be redesigned with the same weights of iron and copper for, let us say, increase of frequency, it may be designed to give an increased load at the same efficiency, or with the same percentage drop, or with the same total rise of temperature, or with the same light load efficiency, and it will have a different output in each case. Again, there is no reason why in the comparison we should adhere to the same weights of copper and iron. We might vary them, keeping the total weight or total cost the same. We thus have at once pointed out 12 different laws of the relation between the output and frequency of a transformer. If other comparisons are made, such as the same bulk with different weights of copper and iron, and if allowance is made for the relatively smaller volume of insulation on a high-frequency transformer, we obtain still more laws. It is therefore sincerely to be hoped the unpractical electrician will not flood the technical press with calculations as to the relations of output and frequency. He has so far spared us the discussion of the output of a phantom curve of sines transformer whose dimensions have been multiplied by *n* Such calculations are quite useless.'

THE TRAINING OF ELECTRICAL ENGINEERS.—III.

Scientific training is very distinct from literary and classical training, inasmuch as it is distinctly acknowledged in the case of science that the training given is for the sake of afterwards putting the knowledge in practice, and in research or further investigation into undiscovered secrets of Nature. Classical teaching is avowedly, in many cases, considered as likely to be of little use to the student hereafter, and the training itself is the end aimed at. Nor is there much possibility of research—the learned have, or it is thought they have, nearly exhausted what was to be found in the classics—pure research holds not out the sweet possibilities that it does in the case of science. Whether or not it be possible to reform classical teaching on the same lines as that of science is being reformed, so that training for the mere sake of training will be some day thought idle extravagance, it is not for us here to say. We are dealing with the training of young scientific men, and more especially with that portion relative to the various branches of the application of electricity.

Prof. FitzGerald, in his letter given last week, made an admission which it will be well to emphasise. He said: "The whole subject of teaching for practical applications of science is in its infancy." It is, truly; and the present, as he further remarks, is the time to mould it. Never, until electricity spread its delicate nerves over the face of the earth, far and wide, have we lived in a really "scientific age." Hitherto science was for the scientific man; now it is for everybody. To be unscientific henceforth is to be left in the race of life; and the man who is fully trained in commerce or literature and knows nothing of science will, in the next generations, be as rare as is now the man who does not know how to read and write. In order that the proper method of teaching science may be developed, fair Science must react upon herself. As she has given means of important discoveries—improvements and progress in material things, we may have the same development in scientific methods of teaching and training. And the point of the whole reform, if reform it is, is very simple: well known, indeed, to many, but certainly not yet thoroughly acknowledged. It can be expressed by the words quoted above with a very slight change. The sentence should read: "The whole subject of teaching *by* the practical applications of science is in its infancy."

What is the difference between a beginner in science now and the beginner in science a century ago? Well, in the one case the student is surrounded by results; the earlier student had perforce to be satisfied by hints of possibilities. The one knows, or might know, where he will arrive; the other did not. The early student could not possibly see a straight path—Ampère could only dream of possibilities, and Faraday could but stand in wonder at the practical outcome in an electroplating dynamo of his magnet and coil experiment. But we of this generation know where their experiments have taken us to, and we are only in a state of expectancy and haze as regards future problems. Then what a waste of mental power is it to place students at the end of the nineteenth century in the same state of hazy expectancy and incertitude of actual result that was necessarily the state of mind of Franklin's contemporaries. Yet this is what technical classes nearly always do: Thales, broken magnets, "double touch," amber, pith balls, and Volta's pile, Ruhmkorff coils, and the rest of the baby scientific tricks far on in the courses are shown, explained, expatiated upon, and examined upon *ad nauseam*—the teachers never apparently reflecting that the beginners must, so taught, inevitably be placed simply in the state of fog that were the old experimenters; and that all their learned talk of theory, principle, and mathematical demonstrations—which have been developed later by far other researches, and after long practical application—can only be understood when the practical applications have been themselves not only described, but seen and experimented with, dissected and studied. In many problems—on batteries, magnets, dynamos, lamps, and transformers—the teacher knows to what point the study will lead—but the student does not, and, too often, will not until the end of the course—often too late to remember the application of what has gone before. In certain problems, however, still unsettled, as, for instance, those of single-phase alternating motors, the Tesla tubes, generation of currents by heat, and so forth, the teachers are necessarily in almost the same uncertain conditions as to exact future developments as are many students with regard to actualities during their technical classes. In a word, the reduction of practice to principles, in order to teach these principles, and the teaching on strictly evolutionary methods, have been accepted as necessarily the only right and true means of education. But the difficulty continually experienced by the best teachers in teaching principles, and the want of success continually experienced by students as judged from the practical men's standpoint, may perhaps lead the teachers to remodel their methods, and consciously investigate the means and adopt it, when found, of teaching by the practical applications of science instead of *for* them.

The want of accurate appreciation of the exact end sought, and of data as to objects aimed at—of where is the useful application in the training given—is certainly largely felt by the students themselves. It is often the case that after some years of work the student looks back, and when at work and face to face with realities, says to himself: "If I had only known what were the important things—exactly what was principal and what subsidiary, what useful and what fantastic, what absolute facts and what mere theory—it seems almost as if I could have learned all I know in one quarter the time." And the fact is that in most cases he could so have learnt it. The time and trouble in investigation that the scientific men have given so lavishly for purely material scientific problems, if given to the psychologic problems of how to teach science, might result in equally splendid discoveries. The efficiency of the human mind could be raised, as that of the dynamo has been raised, by the use of suitable scientific methods. We had an illustration of the mental attitude of disappointment at efforts at first misdirected in the remarks of a correspondent, "Electric Light," in our last number, and other students could no doubt corroborate his view. Misdirection of effort in a student is necessarily so many years' loss; and when it is not uncommon for young men of 24 to be holding, and thoroughly capable of holding, really responsible positions in electrical engineering, those who are not doing, or cannot do so, must by this know that their efforts have been to that extent misdirected, and their training has been inefficient.

We are pleased to see the interest that has been widely aroused by our articles. This proves that the subject is one on which much yet remains to be done in the way of proper organisation and careful thought—from school, through college and workshop to the electrical engineer's works or office—before the profession at large is satisfied with the direction of the training of young electrical engineers.

We have received the following letter from Mr. W. T. Gray, the manager of the India Rubber and Telegraph Works Company at Silvertown, where a very large number of men in every branch of electrical work are constantly employed:

"In reply to your enquiry, the subject you name is one on which it would be difficult to express any opinion which would meet the case in all its points. The electrician of some years ago, was, I take it, much in the same position as the millwright now, fast disappearing. That is to say, he was required to have a thorough knowledge of every branch of the profession in which he was engaged. At the present time, the natural tendency—following the development of the industry—is to specialise, and obviously an electrician must have a training different from that required by a telegraph operator. Nor should the training of an electric light engineer be the same as that of a telegraph engineer. Perhaps your question would be best answered by taking the case of the electrical engineer only, as this class is likely to be in the majority; and it is to this branch that most young men will address themselves. Whatever the sub-divisions of this branch may be in the future, evidently the basis will be engineering; and the intending electrical engineer should take up both the practical and theoretical work connected with this profession.

Probably the best course is a good school education, followed by an apprenticeship with a mechanical engineer. The theoretical work connected with mechanics could be acquired at the evening classes. After three years of such work, a fourth year could be passed in an electrical testing-room, where the pupil could gain experience in the testing of cables and all electrical appliances—such as dynamos, motors, batteries, etc. This should complete the apprenticeship, and enable a start to be made in what may be termed electrical engineering. The commercial side of the work can be picked up as required by a well educated youth, and should, I think, be considered for the time as of quite secondary importance. Business itself is a profession; and it is obvious that it is impossible to expect all youths to be commercial men and engineers at the same time. And, in any case, for some years the pupil should be content to address himself solely to the profession he has chosen.

"With a good training, presumably electrical engineering is like everything else; and with intelligence, honesty, industry, and a fair allowance of the sixth sense, it should be difficult to fail.

"The technical colleges at present, as I understand them, are better fitted for training electricians than electrical engineers; but as the demand for these latter is now considerably in excess of the demand for electricians pure and simple, these colleges will no doubt accommodate themselves to meet this demand by giving the special training required. The workshop, however, is in most cases to be preferred, as in addition to gaining practical experience as to how work is done commercially, intending electrical engineers have an opportunity of associating with those with whom they will ultimately require to work."

The difference above emphasised between the old-fashioned electrician and the modern electrical engineer is very important, and now is widely recognised. This is indeed the general note of the letters we have received. It is therefore with pleasure that we give the following letter from Mr. Sydney F. Walker, who has very distinct ideas upon the questions raised, and his ideas upon educational electrical engineering will be read with interest. He says:

"As I have had the supervision of the training of young fellows who were hoping to become either electrical workmen or electrical engineers for some 15 years past, and as during that period a large number have passed through my hands, all of whom have done well—even several whom I should hardly have expected to—I may at least claim that the method adopted is warranted by success. In the districts where my works are known, anyone who is able to say that he has worked there has always been sure of employment. I mention this as some of the views I hold on the matter are diametrically opposed to those held by a number of the profession.

"I hold, for instance, not only that it is not necessary for an electrical engineer to be also a skilled mechanical engineer, but that if he spends the three years which many eminent men judge necessary in acquiring mechanical engineering, he is placing himself just three years behind in the race. On the other hand, I hold that you cannot place too high a value upon education, both before a youth enters the works, while he is there, and afterwards when he has become a bread-winner. The more the young engineer can acquire of mathematics, the physics, and chemistry, the higher the position he must take in after-life. There is a time, however, as it has always appeared to me, when pure school work should cease, and the practical work of life, the rough-and-tumble work, should commence. For lads who are to become workmen, I find this age to be from 15 to 16, and for those who are to become electrical engineers from 17 to 18 years. Both continue their apprenticeship to about the same age, 20 to 21 years. I find that it is of no use taking a boy who is to become an electrical engineer at 14 or 15 years of age, as he is not old enough to be placed in responsible positions at the time when the knowledge that he has acquired would fit him for them, and he therefore misses a very valuable part of his training. He is usually still a boy, full of a boy's larks, when he should be beginning to take some of a man's responsibilities. If, on the other hand, the school or college education is continued much beyond the age of 18 years, it is difficult to break the subject into workshop ways. Of course, this is not the case where the years from 18 to 21 are spent in a mechanical engineering works, but, as I have already stated, I object to this course for other reasons.

"I believe that I also differ from a great many electrical engineers in the opinion I hold that it is not necessary for an electrical engineer to be a skilled workman—that is to say, for him to be skilful with his hands. In my own works I have always gone on the assumption that the training of an electrical workman and that of an electrical engineer should be quite different. My view has been that the apprentice—as I have termed the lad who is in training for an electrical workman—should have his hands trained to the highest degree possible, and that his head should wait upon his hands. With the articled pupil—as I have named the youth training to be an electrical engineer—my efforts were directed to training his head to the very best advantage, his hands waiting on his head. An apprentice must remain at a particular tool till hand and eye are trained so that he can hardly help fitting accurately and quickly. But I do not consider it of importance that he should know why wrought iron, for instance, is better than cast iron for certain purposes; why a covering of cotton is sufficient insulation for a wire under certain conditions and not under others.

"With an articled pupil I do not care a bit whether he can file square or not, but I do want him to know what is the result of bad fitting, of employing inferior iron, why different substances are used for insulation under different conditions, etc. I see no advantage in an electrical engineer being able to build an engine; but I do require that, in case of necessity, he shall be able, by watching an engine or a dynamo, to see where either of these are working badly—and this he can get in practical electric lighting work, without passing through shops where engines and boilers are built.

"This brings me to the question which I think is often overlooked, what is expected from an electrical engineer when he has finished his training? He is not expected to be able to repair an engine or boiler; he is expected to see or hear signs of failure in either in time to prevent breakdowns, just as he is expected to see signs of possible failure in a dynamo or accumulator under his charge; but this he will get in actual experience, not by seeing the engine or boiler made. Any knowledge that he can pick up, of course, that will enable him to repair sudden breakdowns of engine or boiler quickly are all good, provided it is not acquired at the expense of more valuable knowledge.

"The idea, too, that the necessary knowledge of electricity can be picked up anyhow, after everything else, is surely a mistake. If there is any branch of knowledge that requires one's whole heart and soul to master thoroughly, it is electricity.

"Further, the purely mechanical training, plus electricity thrown in, is a very dangerous training. The requirements of mechanics and of electricity for successful work are very frequently opposed to each other, and the training of the mind in each is such as to strongly militate against the proper thinking power in the other. Mechanical engineers, for instance, who have merely the knowledge of electricity that has been recommended thrown in, usually fail to grasp the intricate problems of electrical engineering that are so constantly turning up.

"It should not be forgotten either that while boilers, engines, and dynamos form a very large part of electrical apparatus in use at the present time, they by no means represent the whole even now, and it may easily happen that a young electrical engineer may be glad to secure a billet in one of the other branches. Of what service will his experience in engine and boiler building be then? And in the future—how soon none of us can tell—it is fairly certain that engines, boilers, and dynamos will be out of date. Once the problem involved in the direct conversion of heat into electrical currents is solved—a contingency by no means so improbable as many readers of the *Electrical Engineer* may imagine—the experience of engines and boilers will be useless, and the time that has been spent on acquiring it will have been lost.

"My view is that the training for an electrical engineer should be electrical, that he should master the principles of electricity and the kindred sciences thoroughly, and should follow the study of the science both in its theory and practice wherever it is to be found, so that he may be able to make himself useful in every branch of the subject, and to be ready for any development that may arise.

"In conclusion, I would repeat what I said in the columns of the *Electrical Engineer* a few years back—viz., 'The electrical engineer of the future must know everything about electricity, and as much as possible about everything else.'"

We have hitherto had expression of opinions to a large extent singularly against the utility of much of the present college training, or at least that of day courses, on practical grounds. This lack of utility must, therefore, have at least a certain basis in fact, and that this is so those who have to deal with students fresh from college courses know too well. Those at the head of such institutions should seriously consider their attitude, and aim to modify to some extent their methods and their curriculum, and if possible overcome this reproach. It should no longer be possible for students, after spending much time and often much money in college, to be told that their knowledge is inapplicable and that far other knowledge is needful. This is, however, by no means even now always the case. We have hitherto only had the opinions of those who see one side of the question. It will be equally interesting to have the opinions of those who have found college-trained men of immediate utility, and if in giving their ideas they would emphasise what from their experience has proved most useful and what it is exactly they require of the young men they engage, this would be equally interesting to professors and to students.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

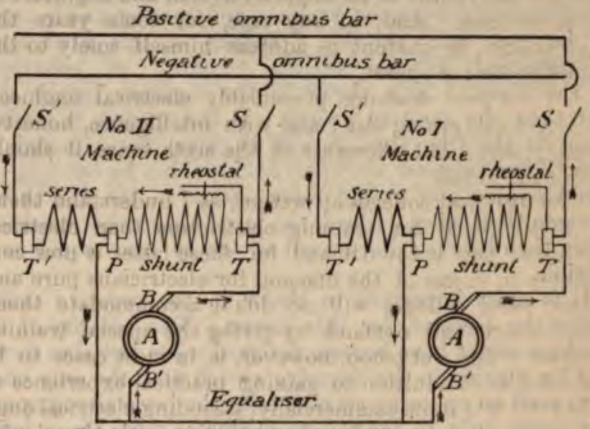
(Continued from page 351.)

Working in Parallel.—In central generating stations it is often essential to be able to throw dynamos in and out of circuit, according to whether the load is heavy or light. By the word "load" is signified the electrical output or energy that is delivered to the mains, and thence distributed throughout the premises or district supplied with light or power.

As may easily be understood, the load will fluctuate up and down very irregularly during the 24 hours of the day, and naturally will be high during the evening and almost nothing during daylight. Every lamp that is switched on means an increase in the electrical output, and hence increased work for the engines and boilers. Similar to distributing mains and pipes for gas, only one network of distributing mains for electricity is used, so that of the dynamos which generate the current each must send its own share into the one circuit or set of mains. When dynamos work together, coupled up, to supply energy to one circuit, they are said to be "running in parallel." As the load increases so machines are started and put in circuit, and as the load decreases so they are switched out of circuit and shut down.

We will now examine the way in which this operation is done, the proceedings being what actually takes place in a central station day by day.

Let there be a battery of six continuous-current dynamos, compound wound, yielding a constant pressure of 100 volts in the lamp circuit, and capable of generating an output of, say, 50 kilowatts, thus giving a maximum current of 500 amperes each. (It is usual with this kind of machine to have a small variable resistance coil inserted in the shunt coils: the object of this is to slightly vary the resistance of the shunt, whereby the pressure of the machine can be increased or decreased a little.) When the machine is working with a heavy load there will be greater loss of pressure along the mains and distributing wires than when working at light load, because the current will be greater. (The loss of pressure is given by multiplying the current in amperes by the resistance of the mains in ohms.) So that in order to maintain the same pressure at the lamp terminals, it is necessary to slightly raise the pressure of the machine as it takes the load on, by utilising this variable resistance; but it is not used so much when a number of machines are working together as when one is by itself, because what would signify a large variation in one machine becomes only a small variation to a number. Fig. 23 gives the diagrammatic sketch of how the above-named six machines are connected up in parallel; only two are shown, the rest being similarly connected. A A signifies the two armatures; B B, positive brushes; T T, positive terminals; S S, positive switches; B′ B′, negative brushes; T′ T′, negative terminals; S′ S′, negative switches; P P, binding-posts for series and shunt coils. The two ends of the equaliser are shown in the diagram as connected to B′ B′, in order to make the diagram simpler; in practice they are really attached to the binding-posts, P P, which is, of course, the same thing—P P thus joins together one end of the series coils, one end of the shunt coils, and the negative brush cable. Sometimes each machine has a third switch, called the equalising switch, for the purpose of disconnecting the negative brush from the other negative brushes; in that case the equaliser is brought up to the switchboard, where it is fixed below the negative omnibus bar. Each machine is supplied with positive and negative switches, all the positive terminals of the dynamos communicating by means of the positive switches to one massive copper bar, called an omnibus bar, from which the positive mains of the several circuits branch off. The positive dynamo terminal, as will be seen in the diagram, forms the positive end of the shunt coil and the positive brush of the dynamo. All the negative terminals of the dynamos, which indicate the ends of the series coils of the dynamos, are connected by means of the negative switches to a second massive copper bar, from which the negative mains of the several circuits branch off. The shunt coils are now put all in parallel by connecting up all the negative brushes of the dynamos, which represent the negative ends of the shunt coils, to a thick piece of cable, called the "equaliser," which generally is run in a chase in the dynamo-room along the line of dynamos. The current from one machine passes by way of the positive brush and positive terminal into the lamp circuit, through the positive switch; returning through the negative switch, it passes by way of the negative terminal through the series coils, then by the negative brush back into the armature again, thus completing the circuit, a small portion of the current, of course, flowing through the shunt coils. The pressure of the lamp circuit is given by a voltmeter whose terminals are placed across the omnibus bars, and a second voltmeter can be used to give the pressure of any individual machine by touching the voltmeter key belonging to that machine.



Compound Dynamos in Parellel

FIG. 23.

Everything being ready, the following is the way to put a machine in parallel: Start the engine, then put down the dynamo brushes, and turn on the pilot lamp. The machine will take a little time to excite itself, and probably a minute will elapse before the pilot lamp grows to full candle-power; when it is thought to be about right pressure touch the voltmeter key of the machine. If too low, speed up a trifle, and stop when the pressure of the machine voltmeter is a volt higher than what the circuit voltmeter reads. Previously to this, slightly lower the pressure of the lamp circuit by, say, one volt, because when the new machine is switched into parallel and takes the load, the other machines, being relieved of some of their loads, would have their pressure slightly raised. This need not be done, however, when there are more than two dynamos working, and another one is about to be put into parallel. Details of this kind must be governed by the various "points" of behaviour of the plant. Now throw in the negative switch first and then the positive switch. If the engine is worked from its throttle-valve, it will be seen that although in parallel the ammeter shows no load, so that by opening the throttle-valve and giving more steam to the engine the dynamo then takes its load, the load in the other machines being then levelled down until all are as near equal as is possible.

It is most important to throw in the negative switch before the positive, for this reason. The polarity of the machine might have become reversed when last shut down, and by putting in the negative switch first, the only effect is to send an opposing current from the lamp circuit round the series coils in the same direction as flows through the series coils of the other machines, thus tending to restore, if necessary, the magnetic field to its right polarity; whilst if the positive switch be put in first, the machine will be put in series with the others instead of in parallel, and the pressure will be doubled. Upon examining Fig. 23 this action will be made clear. By the use of the negative switch another advantage is found. Suppose the load increases very suddenly, due to a fog, etc., and the machine must be put into parallel without loss of time. By leaving the brushes up and then throwing in the negative switch, the field is excited almost at once by a current from the other machines, hence its pressure quickly rises and prepares it for putting into parallel. This "short cut" is not to be recommended, however; if possible, better be sure, though slow, for if in the excitement of the moment—and central-station engineers do get excited sometimes—the positive switch got put in by mistake instead of the negative, and the brush happened to be down, then —— ! ! !

Now coming to shutting a machine down. The first thing to do is to reduce the current or load of the machine which is to be shut down; this also can be done very effectively by manipulating the throttle-valve. It is not wise to reduce the current to nothing, because in large-range ammeters, reading many hundreds of amperes, very small amounts cannot be relied upon, particularly if the instrument is a little out of adjustment, as sometimes happens, and there is a risk of the dynamo receiving a back current, so that a margin of a small current should be left. Previous to this, however, the pressure of the lamp circuit should be slightly raised, if deemed advisable, in order to allow of the remaining machines to take up the load which is thrown off the machine about to be shut down. Everything being now ready, the driver with his hand on the starting valve, the signal is given, and the needle of the ammeter watched. Immediately it begins to move towards zero the positive switch is thrown out, thus throwing the machine out of the circuit. With a little practice, and knowing your driver, this can be done neatly at the right moment and without the smallest spark. The negative switch is thrown out after the positive.

It is quite as easy to work alternate-current machines in parallel, provided you know how to do it, and it is only comparatively lately that the practice of doing so has been adopted. When dealing with continuous currents, there is only the matter of pressure to trouble about, but with alternating currents the pressure and also the current rises and falls, and it is necessary for each machine to be exactly *in phase at the moment when they* are put in parallel—that is to say, the pressure waves of the machines must coincide and rise and fall simultaneously: this condition is what is technically called being "in step."

(To be continued.)

ELECTRICAL DISTRIBUTION.

Gradually the various exigencies of central-station working are being met and successfully overcome. The latest step in distribution is in an improvement designed by Messrs. Crompton and Chamen to overcome principally the difficulties introduced by the charging and discharging pressure of accumulators. These electrical engineers employ a special dynamo, which they term an up-down dynamo, designed with a view to meeting the difficulty experienced in using accumulators in connection with dynamos upon any system requiring sudden heavy currents beyond the normal capacity of the dynamo or engine. The difficulty is that of maintaining the pressure even approximately constant, as accumulators require a higher voltage to charge them than that at which they will discharge. For instance, to take a simple case, a supply at 100 volts is required and a dynamo is arranged to give this pressure constantly. This will, however only charge 39 accumulator cells at 2·5 volts per cell, and, in consequence, the volts obtainable from the cells when they are discharging will only be about 78. If, therefore, the dynamo is overloaded, the accumulators will not assist it until the pressure has fallen to 78 volts. The pressure with such a system will therefore vary from 100 to 78 volts.

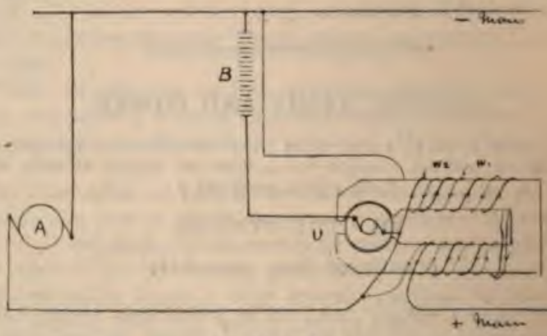


Fig. 1.

If, however, we assume the main generating dynamo, A, in Fig. 1, to be arranged to run constantly at 100 volts, the battery, B, to consist of some number of cells between 39 and 50, say, 45, and the up-down dynamo, U, which is coupled in series with the latter to be capable of giving at a moment's notice about 12 volts *in either direction* according to the demand made upon the mains, it will be seen that if the dynamo normal current is 100 amperes, and the maximum demand upon the mains 200, the difference between these two values—viz., 100—may be supplied by the battery entirely without any fall in the main pressure.

The up-down dynamo is wound as shown, with two windings, one of which, W_1, is an ordinary shunt winding, such as to excite the magnets sufficiently for giving its full voltage (12) in one direction—viz., that for charging the accumulators; and the other, W_2, a very heavy main winding, wound, however, in the opposite direction to that of the shunt, so that any current passing through it opposes, and, if sufficient in quantity, can entirely reverse the effect of the shunt and produce full voltage (12) in the other direction—viz., that for discharging.

The last-named main winding is coupled in the main leads, so that the whole current in the mains must pass through it.

The working of the arrangement is as follows: If the mains have no demand upon them there will be no current in the main winding, W_1, and the up-down dynamo, which may be driven from the same engine as the main dynamo, or by a motor if desired, will give 12 volts to assist the 100 from the main dynamo to charge the battery, which will be found to be about 2·5 volts per cell for 45 cells. If there is a demand upon the mains for about 100 amperes, this current flowing through the main winding will neutralise the effect of the shunt winding exactly, and the up-down dynamo will give no volts at all, and consequently practically no current will either flow out of or into the battery. Almost the whole current from the dynamo will therefore pass direct to the mains, and no appreciable increase will be made in the demand upon the main dynamo.

Again, if a demand for 200 amperes is made upon the mains, the whole of this current passes through the main winding, W_1, and completely reverses the polarity of the up-down dynamo, so that it gives 12 volts in the other direction—that is to say, it assists the accumulators to discharge by adding 12 volts to their normal discharge voltage of 90 (45 cells × 2), making a total of 102 volts, so that the load upon the main dynamo will still remain at about 100 amperes.

Any intermediate loads will be automatically dealt with by the up-down dynamo, so that the battery either absorbs the balance of the 100 amperes which may not be required in the mains, or gives out the excess above that value which may be so required.

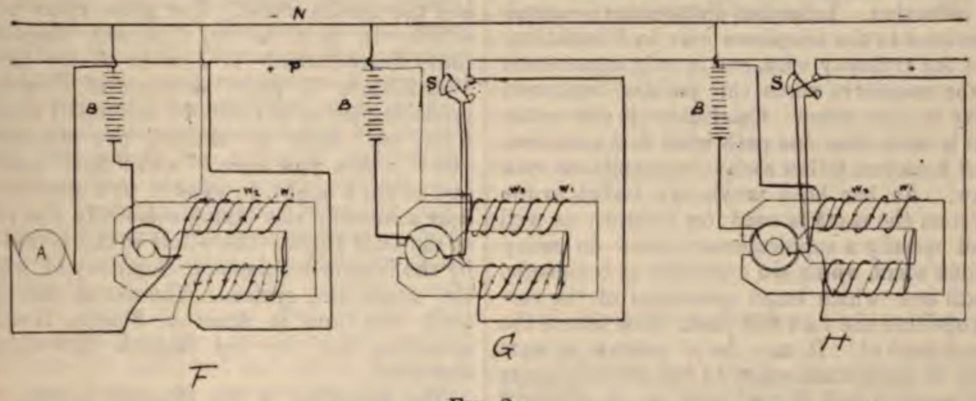


FIG. 2.

Fig. 2 shows a somewhat similar arrangement, which may be employed in some special cases. Only one winding is used in this case, the main winding.

The number of accumulators would only be about 39; the main dynamo remaining as before. The 100 volts pressure would be sufficient to charge the cells, and there would be no voltage given by the up-down dynamo at all until a demand was made upon the mains. At 100 amperes the up-down would give 12 volts, and prevent the charging of the cells, and at 200 amperes would give about 24 volts and assist the cells to discharge.

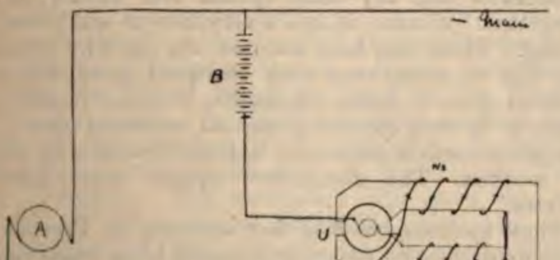


FIG. 3.

It will be noticed here, however, that the small dynamo is not reversible at all, that it must be capable of giving 24 volts × 100 amperes—*i.e.*, about double the size required in the other case—and that its armature will have to carry the full charging current when running at full speed, when the field is quite unexcited. The arrangement in Fig. 1 will, therefore, probably be found more convenient in most cases.

Fig. 3 shows an extended application, such as might be used upon a line of railway or tramway.

F is the generating station arranged as first above described, and supplying current into the mains, P and N. G is a sub-station containing a battery and up-down dynamo as in the generating station, the up-down dynamo being driven at a constant speed by a motor supplied with current from the mains or by any other convenient means. H is similar sub-station further along the line.

The switches, S S, in the sub-stations are kept, as shown by the full black lines, in the ordinary way, so that only the current passing beyond the sub-station under consideration passes through the main winding. When, therefore, there is no demand upon the mains there is a general tendency for every battery sub-station to pass on its current to the one next until all the batteries become fully charged and rise to their natural voltage, thus to some extent automatically reducing the current given out from the generating station. It will be seen that this arrangement of battery sub-stations much facilitates the working of a long railway by distributing the energy to different spots along the line, where it remains stored up until required by a passing train. The action of the whole arrangement can easily be traced out from the explanations here given, and those referring to Fig. 1.

The switches, S S, are provided to allow of any sub-station giving assistance to a passing train even after it has passed it. To effect this, the switch is moved to the dotted position just as the train passes, either by a signalman or automatically, and the current will still come from the sub-station battery, passing through the main winding and making the up-down dynamo give volts to assist the discharge until the train has reached a point, say, half-way to the next sub-station, when the switch is returned to its normal position.

This method of distribution may be modified to suit charging a distant battery station for lighting and general purposes from a feeder, or even from a network, without raising or interfering with the normal voltage in that feeder or network, and it is also particularly useful in connection with electric welding with continuous currents, such as the Benardos system.

TRAMWAYS v. TELEPHONES.*

BY S. SELLON, C.E.

There are few industries hampered with vexatious restrictions as the tramway industry, and the cause of the backwardness of the many advantages to be obtained from the use of tramways was truly stated by the Marquis of Salisbury at the opening of the Liverpool Overhead Railway to be due to unwise legislation. From the promoter (who is beset by the cut-and-dried red-tape rules of previous legislation, and who, before he can obtain his Act, has to give the greater part of his substance away to local authorities), the engineer (who has to carry out these conditions), down to the manager (who has not only got to work to these conditions—accompanied with vexatious Board of Trade regulations—who has also to supply a service satisfactory to the public, and at the same time to provide a dividend for his company), their lot is no bed of roses.

For some years tramway managers have viewed with considerable interest the progress of electric traction, and many have no doubt looked forward to this particular mode of traction being adopted in the future upon their tramways. The enormous growth of this business in the

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* Paper read at a meeting of the Tramways Institute held at Liverpool on April 13, 1893.

United States is well known to us, and the few examples we possess in England have proved its advantage. Many systems have been tried and adopted. The only successful system—and by successful I mean commercially successful system—at present in use is that known as the single-wire system.

What is known as the single-wire system may be generally described as a system of conveying electrical power to a moving vehicle by means of wires or other suitable conductors, and by completing the circuit from the moving vehicle back to the generating station by the use of the earth, the rails, or continuous masses of metal, such as the entire structure of an elevated road, or the iron tunnel of the City and South London Railway. The chief distinctive feature of this system is that the current returning from the moving vehicle to the generating station is not confined to a path which is parallel with the supply current, and this is the particular feature that causes disturbance. The system in use by the National Telephone Company is exactly similar in principle, differing only in mechanical details.

The disturbance caused by tramways is of two kinds—conduction and induction. Induction disturbance is caused by currents generated in the telephone wire by fluctuations in the current of the tramway wire, and is only experienced in cases where the respective wires run parallel with and in close proximity to each other. Conduction is due to the fact that if there is more than one path open to the current, it will divide and a portion follow each—in compliance with a well-known law. As has been previously stated, in the single-trolley system the earth is used for a return as well as the rails, and usually a supplementary wire—in many cases the telephone wires, which are grounded at both ends, form another path over which small quantities of the current used for propelling the cars will pass. This causes the disturbance complained of. It may be of interest to state that the quantity of current necessary to disturb telephones is less than a thousandth part of that used in an ordinary electric call-bell. It will thus be easily seen that we do not pour large quantities of electricity into telephone wires, as the statements of the National Telephone Company would lead one to believe.

The advantages of the single-trolley system may be briefly stated as follows: The use of the earth as a return circuit reduces the resistance of the return to practically nil, thus requiring but little more than half the quantity of copper required for a metallic return. It also allows the positive and negative wires to be kept at the maximum distance apart, and in such *relative* positions as to cause the minimum of complications and difficulty of construction, thus minimising the chance of failure of the system. The National Telephone Company, having been advised by their electrical engineer that the use of the single-trolley system would destroy the working of their telephones commenced, in 1885, an insidious warfare against all tramway companies asking for electrical powers unless they agreed to insert certain protective clauses, copies of which have been distributed. Many tramway companies, in ignorance of the future effect to them of these clauses, accepted them; others who may have known what the effect to them of these clauses would be have accepted them rather than fight such a strong body as the National Telephone Company; and in some cases the matter has been fought before committees in both Houses, and in these cases with some considerable degree of success on the part of the tramway companies.

I am anxious to point out as clearly as possible that any tramway company accepting these clauses as demanded entirely debars itself from the use in the future of the best and most economical system of working tramways known. It is fair to urge that in all questions where vested interests claim protection there should be a certain equity allowed in such protection. It will be plain to all those studying these clauses that there is no equity in them, and although the National Telephone Company have been good enough to state that they have provided an equitable arrangement by inserting an arbitration clause at the end, there are gentlemen in this room who will agree with me that, providing a disturbance to the telephones did occur, such is the artful manner in which these clauses are drawn, that the arbitrator would be unable to give any other decision but in favour of the telephone company, and this has been admitted in committee by Lord Kelvin.

The question before us is, therefore, on what grounds do the National Telephone Company claim protection clauses? They are a company possessing no statutory powers. Secondly, they only hold a license for operation from the Postmaster-General. Thirdly, in a great many towns they are liable under their agreements with the local authorities to take up their poles at seven days' notice, and on these grounds the author claims that they have not the one essential feature for the obtaining of protection clauses—that is, a *locus standi*. Vested interests, however, are so strong in this country, that up to now the telephone companies have always been granted that *locus standi*. It will be well, therefore, to consider that supposing they do possess in equity a *locus standi*, on what grounds do they claim protection? Mr. Justice Kekewich, in his judgment in the Leeds case, says he has had ample evidence before him to show that the single-wire system is the best.

The system adopted by the National Telephone Company in England is admittedly the worst in use. The prices charged in London are higher than in any European city, and the service worse. The great value of the telephone service is, first, secrecy; second, despatch: neither of these do we obtain. If I were to try to telephone from Westminster to your secretary at Finsbury, it would be probable that after about 10 minutes I should be told that I was on. After an exciting five minutes of "Who are you?" "Are you there?" and "Spell your name, please," and so on, I might, in answer to a question to Mr. Elliott, hear somebody else asking somebody else to dine with him at the Café Royal. The whole of this is due to the adoption by the National Telephone Company of what is known as the single-wire system. The use of this system is essentially bad, and in America, France, Sweden, and other countries, and by the English Government, has been discarded.

The following is Mr. Preece's opinion of this system, who, as you know doubtless, is the electrical engineering chief to the Post Office, and one of the greatest authorities upon telephones in the world: "The only really effective mode of getting over disturbances due to induction between wire and wire is the metallic circuit system. The British Post Office and the French Telephone Company are the only administrations that have decisively adopted this plan. The principal objection raised is that of expense, but this disappears on investigation, for while the prime cost may be higher, the improved service leads to a largely enhanced income. When the absolute perfection of working of the metallic-circuit system is experienced, it is remarkable that any other system ever should be contemplated. Human nature is very loth to admit that it is wrong. Those who have matured the one-wire system do not like to sweep away their cherished plans, but as the systems grow it seems impossible to conceive that they continue to work effectively such an imperfect plan. The use of the earth is essentially bad, and it admits an infinity of troubles. The double-wire system must infallibly survive."

These opinions, based as they are upon Mr. Preece's very wide experience on the subject, appear to be unanswerable. Not only is the soundness of his advice generally admitted by electricians, but it is well known that if adopted it would remove the cause of the strong complaints made against the present telephone system in London, complaints which must grow more and more frequent as the electric mains are put into work. If therefore a new system offers itself which can be adopted with safety and economy to supplant horse traction, or the steam tramway engine, it should not be imperilled at its commencement by the action of private enterprise possessing no statutory powers.

The author was the first to make a really solid attack against the introduction of these clauses, and he was successful in obtaining a clause known as the Wellingborough clause, which was absolutely satisfactory for his purpose. In the second fight in which he was engaged he obtained a clause known as the Weston clause, which again was a considerable modification on the proposed telephone clauses In the Sandgate and Hythe case, the most important fight which has ever been before the House, the question went

ly into the cost of the duplication of an electric traction
m *versus* the cost of duplication of the telephone system.
is case, the experts employed by the National Tele-
e Company—viz., Lord Kelvin, Dr. Hopkinson, and
rederick Bramwell—stated that the cost of duplication
e electric traction system, by which their telephones
d not be disturbed, would be from £30 to £40 a mile, and
the cost of duplication of the telephone system would
10. 16s. a mile. Knowing how impossible it would be
set such evidence by the use of figures, it was agreed
cept them, and we stated that even if the system could
orked, which we denied, it would cost at least £1,000
le extra. We would be prepared, however, when we
to put up our electrical installation, to give a cheque
e National Telephone Company for the £40 a mile for
to do it for us. On being asked by the committee
her they would accept this they refused, and the result
hat the committee refused to give them any clauses at
nd also made them pay the expenses of the whole
iry. Perfect faith in their electrical experts is not one
e many failings of the National Telephone Company.

u have all no doubt followed with considerable interest
ate trial before Mr. Justice Kekewich of the National
hone Company *v.* Graff Baker. The result of that action
hat a verdict was obtained in favour of the tramway,
e ground that having statutory powers to use elec-
y, we have a right to be a nuisance; and I wish to
your attention particularly to the fact that Mr. Justice
wich stated distinctly in his judgment that he con-
ed that he did not feel himself bound or called upon
ecide whether or not the telephone company had a
non-law right, and he also thought that such a ques-
should be settled, not by a judge of the first court, but
e judges of the Appeal Court. The telephone com-
have given no notice of appeal, and we can only
ose that it is because they are afraid they will be told
have no common-law right, and the result of such a
ct would be that having no common-law right they
d be debarred from obtaining any *locus standi*. They
therefore been content to rest on this verdict, and
deliberately attempted to throw dust in the eyes of
Board of Trade by writing to them demanding the
ulsory insertion of their clauses in all future Board of
e orders, because Mr. Justice Kekewich has said that
iving tramway companies statutory powers without
nsertion of their protective clauses they are barring
from using their common-law right, and this is the
de they intend to maintain in all provisional orders
ramway Bills of this session.

herefore wish to appeal briefly, but at the same time
bly, to all tramway companies and their advisers that
e interest of tramway traction in the future a strong
ination should be forced to fight the grasping demands
e National Telephone Company. Such a combination
now been formed under the name of the Electric
ion Association. Its object is to assist tramway com-
s who are members of the association, in fighting
st the extortionate demands of the National Tele-
e Company. The association will have the ser-
of the best counsel obtainable, and the best
rt evidence at their command, and will also be willing
ssist towards the expenses incurred in opposition.
nsiderable sum of money has already been subscribed
e leading electric traction firms, and I urge you all to
ne members of this association. The subscription fee
all. This is for the purpose of inducing a large
er of tramway companies to come in, as their moral
ort is of as much importance to us as their money.
particulars of this association are before you, and you
see that any subscriber to the amount of 100 guineas,
representative of sums to that amount, ensures a repre-
tion on the committee.

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ngton.—Islington has determined to follow the lead of St.
as, and to municipalise the supply of electric light. The
y has unanimously adopted the report of its committee to
nto operation as soon as possible the "Islington Electric
ing Order, 1893," to establish a central station for the parish
an installation capable of supplying 20,000 lamps of 8 c.p.
0 arc lamps for street lighting, and to borrow £60,000 to
e the required site and plant.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS.

BY ALBION T. SNELL, MEMBER.

(Continued from page 379.)

[ERRATUM.—On page 379 of last week, column 2, line 8, read: "the cross-section of the common return must be increased by 1·4 times."]

5. TRIPHASE OR DREHSTROM CIRCUITS.

An inspection of Fig. 3 will show that in order to reduce the variation of the field magnetism it is presumably necessary to increase the number of circuits. Take four with phase differences of 45deg. The field excitation will be nearly constant, but eight wires will probably be required; for it is doubtful whether common returns similar to a direct-current five-wire system would be practicable.

Yet the next advance in multiphase working was made by using three circuits with currents differing by 120deg. in phase. Since the phase difference is increased this does not seem a self-evident improvement; but on closer study it is seen that the excitation is more constant, and that the algebraic sum of the three currents is equal to zero.

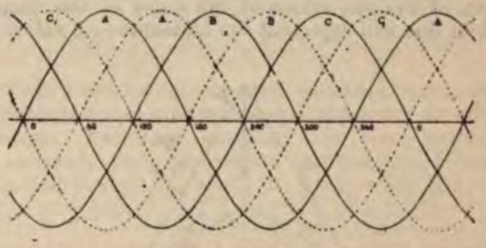

FIG. 4.—Three Periodic Currents Separated by a Phase Difference of 120deg.

In Fig. 4 let A, B, and C represent three periodic currents separated by a phase difference of 120deg.; and let the instantaneous values of the currents be severally represented by C_1, C_2, C_3. Thus—

$$C_1 = K \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C_2 = K \sin \left(\alpha - \frac{2}{3}\pi \right) . \quad . \quad . \quad . \quad . \quad (2)$$

$$C_3 = K \sin \left(\alpha - \frac{4}{3}\pi \right) . \quad . \quad . \quad . \quad . \quad (3)$$

And $C_1 + C_2 + C_3 = 0$ by hypothesis. For

$$K \left\{ \sin \alpha + \sin \left(\alpha - \frac{2}{3}\pi \right) + \sin \left(\alpha - \frac{4}{3}\pi \right) \right\} = 0,$$

which is easily proved to be the case.

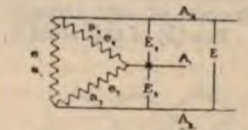

FIG. 5.—Parallel, or Closed Circuit, or Triangle Drehstrom Coupling.

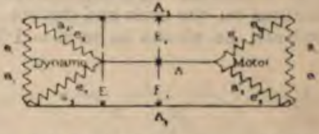

FIG. 6.—Drehstrom Dynamo Coupled to a Motor.

Drehstrom working is accomplished by parallel or series coupling of the circuits, the two methods being severally known as the star and triangle systems. The author regards as the field magnet that part of the machine in which the rotary field is produced. In a triphase motor, then, the field magnet will be that part which receives the Drehstrom from the mains, regardless of whether it rotates or not. In the dynamo there can be no confusion, for the field magnets, in present designs at any rate, always rotate and are excited by a separate direct current. In this paper large capitals are used to distinguish the main carrying the Drehstrom, and italics to denote the three windings on the field magnets of the motor, or the armature of the dynamo. Suffixes are used to mark the phase order of the circuits. It is also assumed that the effective values of the current are read by dynamometers, and that of pressure by voltmeters of the hot-wire or electrostatic type.

The parallel or closed circuit, or triangle coupling, is shown in Fig. 5. Let A_1, A_2, A_3 be the effective values of the several currents flowing in the mains, and a_1, a_2, a_3 the corresponding effective currents in the coils. Also, let E_1, E_2, E_3 be the effective pressures at the terminals of a_1, a_2, a_3. And assume $A_1 = A_2 = A_3$; then $a_1 = a_2 = a_3$, and $E_1 = E_2 = E_3$. And let there be no self-induction or capacity.

With these assumptions, since a is in phase with e, and A lies 30deg. removed from a, it follows, if the mains be fed with a combined three-phase current (as in Fig. 6), that the current in one main will differ in phase by 30deg. from the pressure between it and the two other mains. This is seen to be the case from the geometrical relationship of the coils and the mains. And it can also be proved that the effective value of the current in each of the mains is equal to 1·732 times the effective current in each of the coils, when the circuits are equally loaded. In Fig. 6A let the currents in the mains and in the coils be considered positive when flowing in the direction indicated by the arrows, and let the phase and magnitude relations of these currents be represented by Fig. 6B. Then if the diagram 6B be supposed to revolve uniformly around its centre, the length of the projections of the sides of the diagram on any straight line will represent the instantaneous values of the corresponding currents; for it is plain that these projections satisfy all the necessary conditions—viz.:

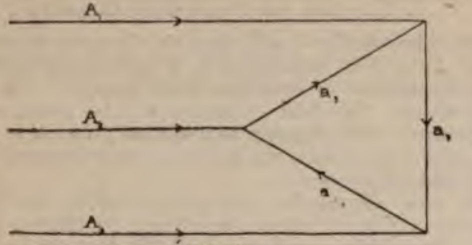

FIG. 6A.

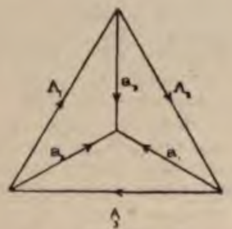

FIG. 6B.

$$\left.\begin{aligned} A_1&=a_2-a_3\\ A_2&=a_3-a_1\\ A_3&=a_1-a_2\\ A_1+A_2+A_3&=0\\ a_1+a_2+a_3&=0 \end{aligned}\right\}\ \text{All instantaneous values—\textit{i.e.}, the lengths of the projections of the corresponding sides of Fig. 6B.}$$

Again, the sides of the diagram 6B are proportional to the effective values of the corresponding currents; and if the load be equally distributed between the three mains, then for effective values,

$$A_1+A_2+A_3=0\text{; and } a_1+a_2+a_3=0\text{; and } A_1=2\,a_2\sin 60\text{deg.;}$$
$$\text{or, generally, } A=1{\cdot}732\,a.$$

The above demonstration was suggested by Dr. Sumpner.

By a similar diagram the relation between the effective pressures on the coils and mains in the open or star arrangement can be shown to be $E = 1{\cdot}732\,e$. See (*b*) of this section.

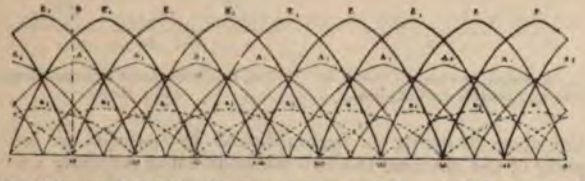

FIG. 7.—Diagram of Relative Position of Curves of Currents in Mains and Coils of a Closed-Type Combined Drehstrom Circuit with no Self-Induction or capacity.

The relative position of the phases of currents and pressure in the mains and coils of a combined Drehstrom circuit of the closed type with no self-induction are shown in Fig. 7 (E and e have the same value, and coincide in phase). It will be seen that the maxima of the currents in the mains, A, are always midway between those of the coils, a, and that the phase difference between them is 30deg.

(*b*) The series, open circuit, or star coupling is shown in Fig. 8. As before, let there be no self-induction or capacity, and let $A_1 = A_2 = A_3$; $a_1 = a_2 = a_3$; and $E_1 = E_2 = E_3$. Now, since the mains, A, are in series with the coils, a, and there is by hypothesis no self-induction or capacity, $A_1 = a_1$, $A_2 = a_2$, and $A_3 = a_3$. But the pressures between the mains are not the same as those at the coil terminals. And e will lag 30deg. behind E and will be numerically equal to $\frac{E}{1{\cdot}732}$,

$$\text{or, } e=\frac{E}{2\sin 60\text{deg.}}\text{, and therefore } E = 1{\cdot}732\,e.$$

The phases of current and pressure in a combined Drehstrom circuit of the open type are shown in Fig. 9 (A and a have the same value, and coincide in phase).

The conclusions thus arrived at are true only on the assumptions (*a*) that the coils themselves have no self-induction, and (*b*) that both the coils and the mains are equally loaded. The first condition is never found in practice, and the second is only likely to obtain with small motors, and then only in an approximate degree. The effect of self-induction is to cause the current in the coils to lag behind the pressure at the terminals. To measure exactly the power of a Drehstrom system, then, is a complicated task; but it can always be done by measuring the work performed in each of the separate circuits and adding the quantities.

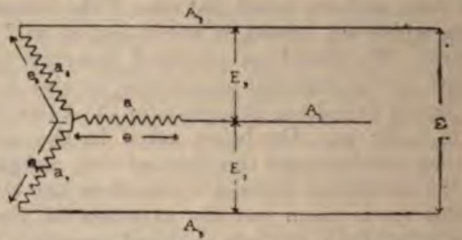

FIG. 8.—Series, or Open Circuit, or Star Drehstrom Coupling.

In Fig. 5, the energy $= 3\,a\,e = 3\,E\,\frac{A}{1{\cdot}732} = E\,A\,1{\cdot}732$ if the three circuits be equally loaded, and there be no self-induction or capacity.

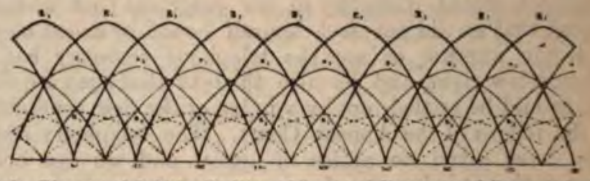

FIG. 9.—Diagram of Relative Position of Curves of Pressure and Currents in the Coils and Mains of the Open-Type Combined Drehstrom Circuit with no Self-Induction or Capacity.

In Fig. 8, also, the energy $= 3\,a\,e = 3\,A\,\frac{E}{1{\cdot}732} = E\,A\,1{\cdot}732$ on the same assumptions.

So it appears if there be no self-induction and an equal load in each circuit, that the number of amperes in one of the mains multiplied into the pressure between two mains into 1·732 gives the power in watts. If there be self-induction, the above quantity must be multiplied by the cosine of the angle of lag between the current and the pressure. The energy absorbed by a motor, therefore, will be expressed by $E\,A\,1{\cdot}732\cos\phi$, where ϕ is the angle of lag.

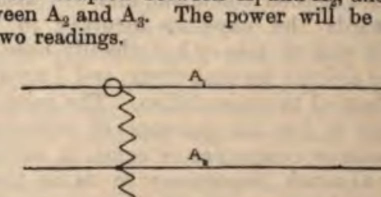

FIG. 9A.

If the three circuits be equally loaded, the power can be measured by one wattmeter (see Fig. 9A). Put the current coil in one of the mains, say A_2, and take two readings, one with the pressure coil coupled between A_1 and A_2, and one with it coupled between A_2 and A_3. The power will be equal to the sum of the two readings.

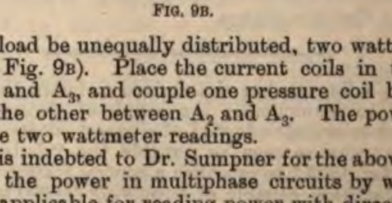

FIG. 9B.

And if the load be unequally distributed, two wattmeters are required (see Fig. 9B). Place the current coils in two of the mains, say A_1 and A_3, and couple one pressure coil between A_1 and A_2, and the other between A_2 and A_3. The power is then the sum of the two wattmeter readings.

The author is indebted to Dr. Sumpner for the above methods of measuring the power in multiphase circuits by wattmeters. They are also applicable for reading power with direct currents.

In part (*a*) of this section it was shown that with combined three-phase currents, even when neglecting the self-induction of the coils, there is a constant phase difference between the current and the line pressure. This, although not in itself a direct loss, is the cause of great difficulty in measuring, regulating, and controlling the currents, and also reduces the output for a given weight of material. Hence it has been found expedient to work the dynamo circuits unconnected, and to use six or more separate coils. The currents from these are combined by a suitable transformer so as to convert the secondary currents into a combined high-tension rotary current with phase differences of 120deg. This high-pressure current is reduced at the motor end of the line by another suitable transformer, and sub-divided as required. In the transformers, says Mr. Dobrowolski, there is not the same constant difference of phase of 30deg. (between the current and the pressure), but owing to the connections of the secondary coils the transformation ratio is not equal to that between the primary and secondary turns, so the latter must be increased to the extent of this difference. The ratio is 2 : 1·732, or a difference of 14 per cent., neglecting all losses from other causes than the connections. The efficiency of Drehstrom transformers is probably not quite so high as that of single-phase ones, but it is not much less, and when the advantages of low-pressure dynamos and motors with high-pressure transformers is fully appreciated, the slight difference in efficiency appears insignificant.

The next point for consideration is the pulsation of the magnetism in the rotary field. This is not a simple matter to represent in a graphic manner, for the magnetic field is not merely the result of the inducing currents in the Drehstrom coils, but it is also largely affected by the frequency and magnitude of the induced currents in the closed coils of the armature, which vary from instant to instant with every fluctuation of load. The frequency of the induced currents will always be less than that of the exciting current—attaining its highest value at full load when the slip of the armature is greatest. It is expressed by $\frac{N-n}{60}$, where N = the number of revolutions of the magnetic field per minute, and n = that of the armature. (If N = 2,400 and n = 1,920, then the frequency will be eight per second.) The average pressure acting in the closed coils will be given by the expression $K\,C\,F\,a\,10^{-8}$,

where K = a constant ;
C = the number of turns counted all round the periphery of armature ;
F = the average number of lines of force from one pair of poles ;
and a = the number of alternations per second of the armature induced currents.

In determining the excitation for multiphase motors and dynamos, it is therefore necessary to make two calculations, one for full and one for light load, just as with direct-current machines.

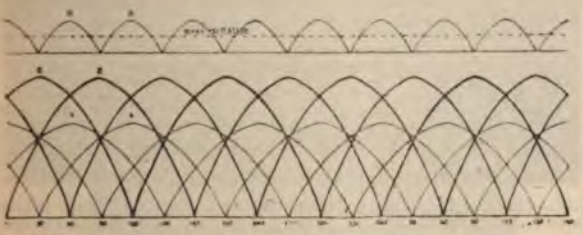

FIG. 10.—Diagram of the Excitation Fluctuations in a Combined Closed-Type Drehstrom Circuit.

It is clear that it is not possible to represent the changes of the rotary field magnetism by a general diagram. Fig. 10 shows diagrammatically the relative position of the current and pressure curves in a combined Drehstrom circuit, with the resultant excitation, assuming the armature reactions to have no effect—*i.e.*, the field and armature are supposed to rotate at nearly the same speed. An arbitrary angle of lag of 30deg. between the pressure and the current in the exciting coils has been assumed, and the curves have been drawn to suit the sine law. The pressure is shown in E_1, E_2, E_3, and the current in a_1, a_2, a_3. The resultant excitation is indicated in curves R, R, R, the limits of which are $2a$ and $1·732\,a$, a mean difference of about 7 per cent. If the magnetism varied as the excitation, then the same fluctuation would occur in the rotary field, but owing to hysteresis and eddy currents the mean variation is probably not much more than half as great, say, from 4 to 5 per cent.

Now, the torque will vary with the ampere-turns, the frequency of the current, and the number of lines of force in the armature ; or, the torque $= \frac{C\,i_a\,F\,a}{K_1}$, where i_a = the armature current, and K_1 = a constant, and the other symbols have the same signification as above. The magnetism is determined by the field excitation, and the number of turns of wire is, of course, fixed for a given armature ; hence, to increase the torque, it is necessary that the armature rotate more slowly.

The "slip" increases both the frequency and the magnitude of the armature current, thereby weakening the resultant field and lowering the current E.M.F. of the field-magnet coils, and allowing more current to flow in the exciting circuit. But since the total magnetism decreases as the armature current increases, there is a point at which the torque is a maximum. This corresponds to a definite current,* which is not the starting or maximum current, and hence these motors do not exert their greatest effort at starting. In order to avoid large rushes of current when closing the exciting circuit, it is advisable to insert variable resistances in series with the armature windings. This is specially necessary with large machines, and it appears probable from this reason, as well as from other considerations, that large Drehstrom motors will always be designed with stationary armatures and revolving field magnets.

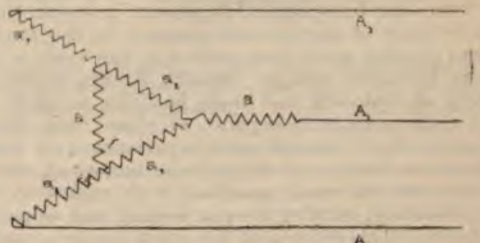

FIG. 11.—Combined Series and Parallel Drehstrom Couplings.

So far, if the difficulty of measuring the power be disregarded, the main point calling for improvement appears to be the magnetic pulsation. The mean variation does not, theoretically, exceed 7 per cent., and, practically, probably not 5 per cent. In order to still further decrease this, Dobrowolski has devised a very pretty combination of the open and closed type windings, which reduces the mean variation of the excitation to 3·5 per cent., when the magnetic field should be practically constant. The winding is shown diagrammatically in Fig. 11, and is known as the double-linked winding. The coils indicated by the symbols $a_1{}^1$, $a_2{}^1$, $a_3{}^1$, are severally wound in two parallel, 15deg. removed from the closed coils, a_1, a_2, a_3. The complications involved are considerable, and the gain, perhaps, not commensurate with them, yet for large machines the device may prove useful.

There are some important points to be noticed between the series and parallel connections. It has been shown that with the series coupling $e = \frac{E}{1·732}$ (see Fig. 8), and that the currents in the coils and mains are the same, and in the parallel device (see Fig. 5), that each coil carries a current equal to $\frac{A}{1·732}$, and that the pressure at the coil terminals corresponds to the pressure between the mains. These differences are suggested by the terms parallel and series, which are in this respect more apt than those of triangle and star.

Now, the magnetising effect exerted by a given number of turns of wire, and a definite effective current in the mains, will be different with the two kinds of windings.

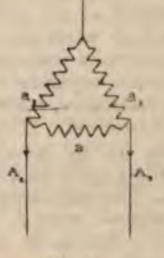

FIG. 12.

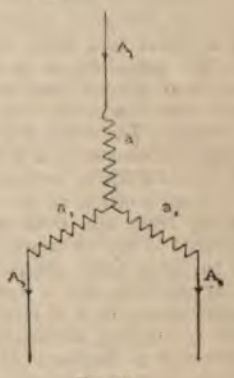

FIG. 13.

Consider Figs. 12 and 13, which severally represent the parallel and series couplings, and the direction of current at the instant when the Drehstrom is entering by one main and returning equally by the two others. Let n be the number of turns of wire in one coil. Then the total ampere-turns in the parallel device is n A, and in the series arrangement $\frac{3}{2} n$ A. Therefore, the magnetising effect and also the self-induction of the series device is greater than that of the parallel for a given current and a fixed number of turns. Now, the total power absorbed by the two circuits may be made the same by a proper adjustment of pressure and frequency ; but since the lag is involved, a complete solution is not very simple. Probably, however, a few experiments made with different-sized machines will do more to assist the constructor than pages of mathematical theory.

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* It is clear that the particular current for maximum torque is dependent mainly on the magnitude of the armature reactions, and if the latter were sufficiently small the greatest torque might be obtained at starting, as is the case with a series-wound direct-current machine. With commutatorless Drehstrom motors it is probable, in the author's judgment, that the maximum effort will be obtained with a current little greater than that required for the greatest output.

It must be borne in mind that the triphase system has not been definitely proved to be superior to the diphase, and the leading authorities on the subject differ strongly. Herr Dobrowolski says that "the diphase current now belongs to the past," because in practice machines give curves departing so widely from sine functions. He admits, however, that if the phase differences of current and pressure be the same in each of the two circuits, and follow a sine law, the work is the same in each at the same instant. Messrs. Brown, Kelly, Stanley, and Kapp all maintain that there is little to chose between the two systems from this point of view ; and Mr. Brown further states that "his extensive experience with multiphase currents shows that two or three phase motors of similar outputs are much the same machines with regard to their respective efficiency, starting torque, weight, and apparent watt consumption. This holds good for synchronous as well as non-synchronous machines." It is generally admitted that the Drehstrom presents many difficulties for lighting, and still more for a combination of lighting and power work ; but continental engineers have to a large extent successfully overcome these. Whereas, on the contrary, the diphase system admits of as a simple treatment as the single-phase one. It appears to be therefore probable that, if multiphase currents come into general use, the diphase may be employed chiefly for combined light and power distribution, and that the Drehstrom may find its field of usefulness in transmission and distribution of power. Experience alone can settle these points.

6. PRACTICAL APPLICATION OF THE DREHSTROM.

With a view of adding to the somewhat scanty practical information on the subject of multiphase working, the author proposes to lay before the Institution a few tests of two Drehstrom machines, designed and built by himself some 18 months ago. These machines were adapted from material at hand, and were built under restrictions as to cost and time, and thus can only be regarded as rough experimental designs. The dynamo was a Gramme-wound 10-unit two-pole shunt machine, designed to give 160 volts and 60 amperes, at a speed of about 1,000 revolutions per minute. Three insulated copper rings, with suitable brushes, were fitted around the commutator and connected to the windings of the armature at points 120deg. apart. The ordinary commutator and brushes were left intact, so that both direct and triphase currents could be taken from the armature ; and the field was separately excited. At a speed of 720 revolutions per minute, the frequency was 12 ∿ per second. This was afterwards increased to 30 ∿ by raising the speed of the armature.

The motor was specially built, and had a laminated ring magnet, with Gramme windings, and a closed-circuit armature. It was estimated to give 3 b.h.p. at abont 1,200 revolutions per minute, and the gross weight was approximately 300lb. The armature plates had holes drilled parallel to the shaft and as near to the periphery as possible without breaking through. In these were placed lengths of No. 4 S.W.G. copper wire, insulated from the plates and soldered at either end to massive copper rings. The field winding consisted of six coils, each containing 68 turns of No. 6 S.W.G. copper wire, and having a resistance of 0·055 of an ohm. Opposite coils were joined in series with each other, so as to make three separate circuits, each of 136 turns and 0·11 of an ohm resistance, which could be connected in star or triangle fashion, as desired. This motor proved to be a very effective machine, having considerable torque at starting, and a speed regulation quite as good as a direct-current machine of similar output. The only instruments available for taking electrical measurements were a Cardew voltmeter and a Siemens dynamometer ; hence it was not possible to measure the angle of lag, or estimate the true watts. The experiments made with the dynamo and motor are shown in the following curves and tables, which at this stage may be instructive, since they show the order and direction of the difficulties met with in Drehstrom working.

(a) *Preliminary Experiments with the Dynamo.*

The three copper rings were connected to points in the winding at 120deg. apart, the Gramme winding being otherwise untouched. The arrangement is diagrammatically represented by Fig. 14. The field was separately excited by 3·05 amperes, and the speed was kept at 710 revolutions per minute. The load was absorbed by iron spiral resistances with small self-induction. Readings were taken of the direct pressure ; the alternating pressure at the ends of the three coils, a_1, a_2, a_3 ; and the current in each of the three mains, A_1, A_2, A_3 (see Fig. 15, curves 2 and 3). It was found that with the armature unloaded the pressure developed by each coil was practically the same ; this was also the case when they were equally loaded (see Fig. 16). But it fell rapidly as the current increased, and so a considerable difference could be made between the pressure of the three circuits by simply giving different loads to each of them.

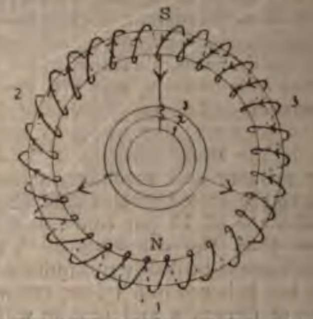

FIG. 14.—Connections of Drehstrom Dynamo, Coils in Series.

The magnetic induction of the armature core, curve 1, Fig. 15, was calculated from the usual formula, $E_a = \frac{N A n}{10^8}$, where E_a equals the total number of volts in the armature, A the number of turns counted all round the armature, N the total flux, and n the number of revolutions per second. It will be seen that the values of the induction measured were all small.

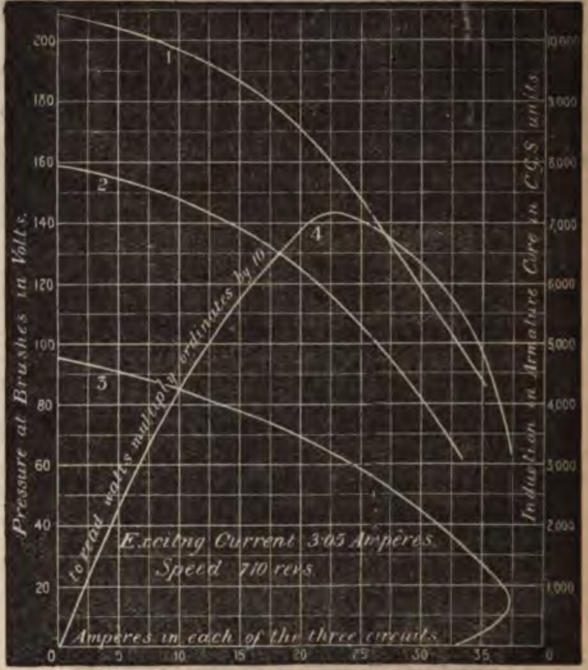

FIG. 15.—Curve 1. Induction in Armature Core. Curve 2 Direct Pressere. Curve 3. Alternating Pressure. Curve 4. Apparent Watts in each Circuit.

The frequency was 12 per second. These conditions were not the most favourable, it is true, but they showed the detrimental effects of internal resistance and self-induction in not only restricting the output, but also in affecting the regulation of the pressure of distribution. It will also be seen that the direct pressure is higher than that of the alternating in the proportion of 158 to 94 on open circuit, and with 20 amperes in each branch (or a total of 1·732 × 20 = 34·64 from the combined circuit) in the proportion of 124 to 70. This difference is to be expected, since the alternating pressure is the average value of 120deg. of the differential curve of potential ; and, further, when the armature is loaded, the self-induction probably increases the difference between the two values. The apparent output, curve 4, Fig. 15, estimated by the product of effective amperes and volts, is found to be a maximum with about 22·5 amperes in each circuit, or 39 in all. The current was next increased in each circuit, so as to find the slope of the external characteristic curve. It was found to steadily fall at about the same slope until 37·5 amperes were reached, corresponding to a torque due to 65 amperes, this current being rather more than that designed for the armature. At this point the belt began to slip, and the experiment was stopped. It is clear that this class of dynamo can be safely overloaded for short periods.

The winding of the armature was next divided into six equal parts and opposite sections were joined in parallel (see Fig. 17). The copper rings were then connected as before to points at 120deg. from each other. Each of the three circuits had now only half as many turns as with the coupling shown in Fig. 14, and one-fourth the resistance. The effect of this alteration was to lower the internal resistance of the armature, and also, presumably, to reduce the self-induction. The excitation was maintained as before at 3·05 amperes, and the speed also at 710 revolutions. The results obtained from the two couplings are shown in Figs. 16 and 18 respectively. It is noticeable that the parallel winding has not materially affected the apparent output of the dynamo. The effective number of turns in each coil is only one-half that with the series winding; and therefore for the same heating effect the number of amperes is twice as great. To compare the two outputs, then, it is necessary with the series arrangement to take only half as many amperes as with the parallel one. Referring to Figs. 16 and 18, it is found that the apparent watts at 710 revolutions per minute are severally 69 × 20 and 34 × 40, or approximately the same. There was probably a smaller lag of current with the parallel than with the series connections. The smaller pressure and larger current were most suitable for testing the motor, and so the parallel connections of the dynamo armature were used during the whole of the following experiments.

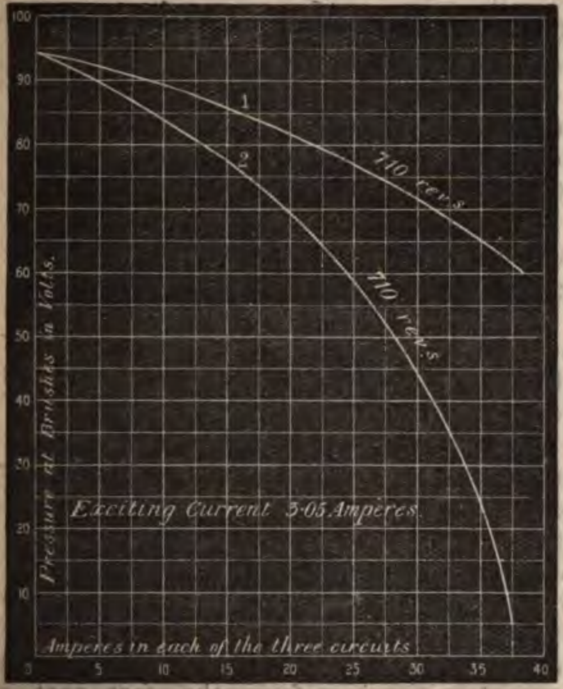

FIG. 16.—Fall of Pressure at Terminals of Drehstrom Dynamo with Armature Coils Coupled as in Fig. 14. Curve 1. Only One Circuit Loaded. Curve 2. All Three Circuits Equally Loaded.

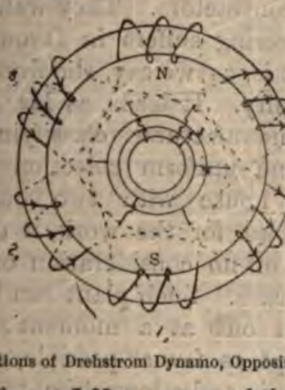

FIG. 17.—Connections of Drehstrom Dynamo, Opposite Coils in Parallel.

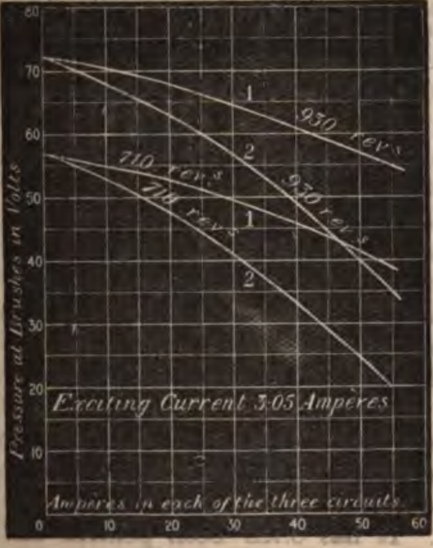

FIG. 18.—Fall of Pressure at Terminals of Drehstrom Dynamo with Armature Coils Coupled as in Fig. 17. Curves 1. Only One Circuit Loaded. Curves 2. All Three Circuits Equally Loaded.

(To be continued.)

SOME APPLICATIONS OF ELECTRICITY TO CHEMISTRY.

Last Saturday afternoon, at the Royal Institution, Mr. James Swinburne began a course of three lectures on the various applications of electricity to chemistry. Now that dynamo-electric machines, said the lecturer, are made which give high efficiencies, and which are low in cost, the applications of electricity to commercial chemistry are increasing, we may truly say, every week, the future development of electro-chemical work will be so enormous that even a bird's-eye view of the subject ought to be interesting. Most of the applications depend on the electrical decomposition of saline solutions or electrolytes. When electricity is passed through an electrolyte it is split up into two components, of which one is higher and the other in a lower state of oxidation. In the simple case of passing electricity through water, oxygen is produced at one pole and hydrogen at the other. Again: if, for instance, chloride of copper is electrolysed, chlorine comes off at one pole and copper at the other. As the terms oxidation and reduction are already so extensively, though loosely, used, and as they apply also to chemical actions performed on bodies which are not electrolytes, it will be better to adhere to those used. The work of a chemist consists very largely in oxidising or reducing the various substances with which he deals. Sometimes, also, he is making changes or substitutions. Here, then, electricity will be of great aid to him. The advantage of the electrical over the chemical method is very great. To reduce water to hydrogen, it would have to be heated in contact with iron, carbon, or something which has enough affinity for oxygen to abstract it from the water. In this case the hydrogen is set free, but the oxygen is not. By electrolysis, however, the oxygen or hydrogen, or the copper and chlorine, are produced direct without any complications and without introducing foreign substances. Electricity has a magnificent future in metallurgy. The important alkali industry consists of splitting up common salt into caustic soda and chlorine, and the process of manufacture as at present carried on is a bewildering maze of oxidation, reduction, and substitution. In making alkali and bleaching powder by the Leblanc-Welder process there are four oxidations, one reduction, and three substitution processes. By electrolysis, salt is decomposed into caustic soda and chlorine at one operation without the aid of any other chemicals, and without any waste or loss. It is probable that sodium and potassium will soon be produced from their fused salts in the same way. The oldest application of electricity is electroplating. The process of electroplating with silver, gold, and nickel is so well known that it will be better not to devote the short time at my disposal to their consideration, except mentioning a few recent developments. Electroplating with silver containing a small percentage of cadmium was a recent improvement. The sulphide of cadmium was yellow, and combining as it does with sulphur more readily than silver, it is said to absorb the sulphur, and to form a thin coating of cadmium sulphide, which protects the silver so that it is not blackened by fumes of sulphuretted hydrogen. It must be remembered that it was by electrical means that sodium, potassium, magnesium, lithium, barium, and calcium were first produced. All these metals, with one exception, were first isolated by Sir Humphrey Davy, Professor of Chemistry at the Royal Institution. More recently electrolysis has been used in the endeavour to isolate fluorine by electrolysing fluoride in a vessel made entirely of a fluoride. In chemical analysis electricity can be a great help. By its means metals can be separated that are troublesome to deal with by purely chemical methods. As an example of the application to analysis, testing for arsenic in forensic cases may be mentioned. One of the most complicated branches of the study of chemistry is the formation of dye stuffs. Oxidation and reduction can frequently be carried out by electrolysis without introducing special oxidising and reducing agents. Here is a wide field for scientific research. Whether such a process is valuable commercially is a matter of doubt, but it is well worthy of further attention to provide the chemist with a new method of investigation, and may lead to important discoveries in this branch of organic chemistry. Electricity also derives benefit from chemistry. Faraday discovered that the quantity of metal deposited was strictly in proportion to the quantity of electricity passed through the solution. This has provided electricians with a very exact method of measuring quantities of electricity. Lord Rayleigh had made very careful determinations of the exact weight of silver deposited by a unit quantity of electricity, and this measurement now serves as the practical standard for the measurement of electricity and hence of electric currents.

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ARE CONSULTING ELECTRICAL ENGINEERS REQUIRED?

The question standing at the head of this article is one to which a decided answer is required, and the answer should be in accord with the prevailing opinion of the profession. At the present moment, unfortunately, opinions are divided, and therefore a statement of opinion is not so effective as it ought to be. In other directions experience has proved consulting engineers to be a necessity. In electrical engineering, the large manufacturing firms, or some of them, rather favour the contention that they are the best judges of what ought to be done, and that the cost of the consulting electrical engineer is wasted. We have always been emphatic in the opinion that the consulting engineer was and would become more of a necessity. Mr. Kapp will, of course, be taken to be rather biassed in his opinion, but if his arguments in the paper read before the Society of Arts on Wednesday be carefully examined, it will be admitted they are fair and very difficult to answer. The one great objection to manufacturers being both contractors and engineers arises from the fact that they are usually in competition one with the other. There is no getting away, then, from the fact that their first concern is to obtain business, and it is not in human nature to be at once independent engineers and contractors. They want the work—and the engineering suffers in favour of the contracting. That is, as we say, the first and the insuperable difficulty. It leads, as Mr. Kapp pointed out, to the manufacturer classifying his plant and making one uniform selection for, say, the lighting of a house with two hundred lamps. That is the plant for the work, it costs so much. There is little or no consideration of any peculiar features of the case. Such plant can be taken from stock and sent out at a moment's notice. His patterns are kept as few as possible, and making to stock is less costly and allows him to tender lower than would making to order. It is useless to attempt to point out all the reasons why the contractor is not the best engineer. Most of us know them, but still are indisposed to admit the necessity of the engineer. This indisposition proceeds, we imagine, from a fear that few of the so-called consulting engineers have had the necessary experience in things electrical to give their designs correctness. It is felt that as yet manufacturers and contractors have had most experience, and should therefore be in the best position to judge what is most suited to the case. Granted that it may be so. Even then the contractor cannot freely follow his opinions; but it is certain that we have consulting electrical engineers, possessing the widest experience, quite capable of designing each plant upon the merits of the case with a due consideration, not only to initial cost, but to cost of maintenance. It has often been pointed out in these columns that "cost of maintenance" is, in the long run, a far more important matter than initial cost, and therefore requires just as much or more consideration. To us it is a pitiable exhibition of ignorance or indecision when either private purchaser, or central-station employer, asks indiscriminately for tenders upon the tenderer's own designs. It is a great loss to many firms who prepare designs and estimates and lose the work, which is too often given, without the aid of an expert, to the lowest or that which seems the lowest tender. Mr. Kapp's paper has raised the question anew, and we trust it will not now be allowed to drop without an expression of opinion from the advocates of both systems.

TELEPHONY AND TRACTION.

Mr. Sellon has done right in his paper before the Tramways Institute to call attention once more to the interactions between telephonic and electric traction interests. The pecuniary interests involved on either side are likely to be vast, as undoubtedly telephony and electric traction are both destined to progress. The whole matter under dispute is just as simple or just as difficult as one likes to make it. The earth is a conductor. Is it equitable for the first comer to deprive every other would-be user of this natural costless conductor? The telephonist is first in the field, he grounds his wires and completes his circuit by the earth. The earth costs him nothing, whereas a metallic return would. Further, the metallic return would be better for his purpose, and his only reason, his only excuse for not using it is the cost. We do not know of anything used largely in trade that is analogous, but the nearest approach is perhaps a navigable river. The water-way is open to all. The first shipowner cannot claim—and would be laughed down if he did—the sole right of way, though other ships do interfere considerably with his profits. The first millowner cannot stop other mills from using the water before or after it has passed his mill. But, as we say, the analogy is far from perfect. Electric currents in the earth are not harnessed to go in one particular direction: they go probably in exact accord with the law of least resistance. Thus, any particular current to go from one point to another may go in a very zigzag fashion. Hence interference. The legal fraternity seem to consider that the man in possession has to be protected. Mr. Sellon practically says this is a mistake. He seems to claim that obtaining "statutory powers" is all that is required, and that a tramway company having such powers is safe, while if a telephone company had them it would be safe. We would prefer the use of the earth as an electric conductor settled upon wider grounds. First come first served, is not the condition to be fulfilled. Are the following questions answerable? Is the earth-return the best system to be adopted for telephony? No doubt the answer to this is emphatically, No. It is most likely the worst system that could be devised. Then, is the earth return, or a system which practically uses earth, the most suitable for electric traction? Here we think the answer would be less emphatic, though many or most people would reply, "Yes." At any rate, it has not the disadvantages of a similar system in telephony. Thus we might fairly ask again, Is it equitable that a "bad" system should be permitted under any circumstances to usurp a place and to "corner" the earth as a conductor in the face of the earth being able to be used to better purposes? The telephone company has a perfect right to prove that the earth-return system is the best for telephony and the worst for traction. This opinion is just the opposite to that generally held, but if it can be satisfactorily proved, then they have a much stronger case for earth control than at present. There is, however, just the chance that to-morrow or next year some other electrical apparatus will be invented more important than telephony or traction, and make a demand to use earth returns. Is the field to be closed to the future either by traction or telephony? But this is going into a wider field than that traversed by Mr. Sellon. He asks tramway companies not to be tempted by the wiles of the telephone company, and to fight against the insertion of a clause in provisional orders giving power to the telephone company.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRAINING OF ELECTRICAL ENGINEERS.

SIR,—In reply to the question in Prof. Fitzgerald's letter, the course of pure mechanical engineering that we advocate as the first part of a practical training in electrical engineering is that the pupil should serve his time for two years in a general jobbing or repairing shop where they make some new engines, boilers, and tools, and carry on extensive repairs as well. There are many such shops in the Manchester district. After two years spent in this way, when the pupil comes to us, he can learn how to construct dynamos, lamps, switchwork, and to deal with the irregular mechanical work that is required in electrical engineering contracts. But we think during the first part of his training the class of shop we have above indicated will give him the best chance of picking up the kind of experience that is likely to be useful to him. We are quite at one with your correspondent who considers that modern electrical engineering is mainly mechanical engineering.—Yours, etc. CROMPTON AND CO.

Mansion House-buildings, April 17, 1893.

SIR,—I notice in your impression of April 14, Mr. Eugène-Brown, speaking of installation work, informs the public that the firm to which he is attached "find joiners and plumbers or bellhangers make the best workmen." These words I think are apt to give the public a wrong impression—that his firm employ joiners and plumbers for wire-laying purposes, and, moreover, find them the best workmen. If Mr. Eugène-Brown were to descend from the lofty throne of dynamo designer, and take charge of a set of men on some installation, he would perhaps discover two useful points:

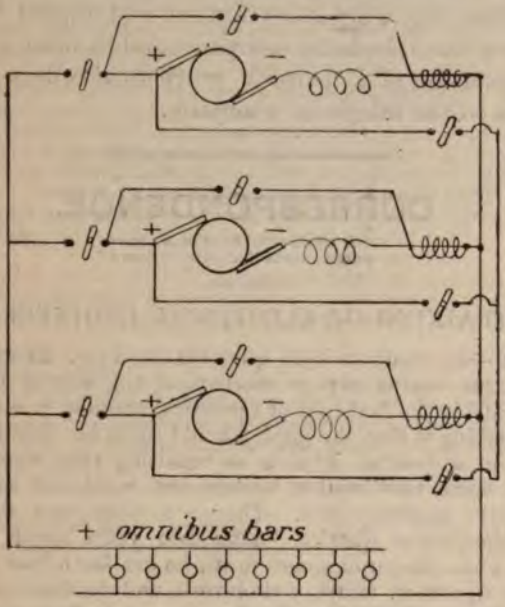
1. The trouble caused by a joiner embracing two different trades both belonging to a trades union.
2. That it is a generally acknowledged fact by chargemen (and who know better?) that joiners and plumbers do not make the best wire-layers, but quite the reverse.

Speaking of premium apprentices, he says: "If he really enquired into the meaning of all he saw from the heads of the departments, he would gain much knowledge," etc. This sounds well, but the writer knows some such apprentices who do enquire into the meaning of a little they see from the heads of the department, but vainly. Why? For two reasons. In some cases the head of the department can't tell you, and in others he won't. One word more to add to the many columns already written on this subject for the last five years. Why should there be so much controversy? If an old hand's advice is any good, here it is: Get the best school education possible; go to a good firm; see everything; work at everything; if you can chum up to the head of a department who will disgorge information, stick to him closer than a brother; but, above all, *watch* and *think*.—Yours, etc.,

TYNESIDE.

CONNECTING COMPOUND DYNAMOS.

SIR,—I have several compound dynamos, 300 amperes, to connect in parallel, whose characteristic curves are not exactly similar. Will you please give me the usual method of doing this, or say if they will work satisfactorily if connected up in the following manner—that is, by connecting the positive brushes through switches to one common bar, these switches to be put on after machines are excited, and before closing main. It is desirable that any machine can be stopped or started at any time according to load.



When switching in a new machine is it usual, after bringing up to full speed, to bring it to same potential as omnibus bars by varying resistance in shunt before closing the main?

If you will kindly help me out of this difficulty I shall be much obliged.—Yours, etc., YOUNG ELECTRICIAN.

[Mr. Guy is just now dealing with this subject in his articles, and "Young Electrician" will probably find therein all the information he requires.—ED. *E. E.*].

REVIEWS.

Electric Lighting and Power Distribution. An elementary manual for students preparing for the ordinary grade examination of the City and Guilds of London Institute Part I., with 125 illustrations. By W. PERREN MAYCOCK, M.I.E.E. Price 2s. 6d. London: Whittaker and Co.

Here is an honest attempt to supply an elementary straightforward text-book to electrical engineering for students, and we will give an honest attempt to review it. Much that is good in the new method of looking at technical training is grasped by the author; much that is bad in the ancient system still exists. Mr. Perren Maycock is favourably known to us by several attempts to provide clear text-books, and that he has even yet not quite succeeded is due to a want of appreciation of the value of organisation and concrete thought rather than any lack of care or knowledge. We will take this text-book chapter by chapter, and see how it fulfils the ideal for an elementary text-book. Chapter I. deals with force, mass, work, power, etc.—abstractions, all of them. You wish to teach electric lighting, and you begin with "force." True, Mr. Maycock begins well with his definitions, wrong though it may be to commence in this way. To illustrate force we do hear of something—*a garden roller*; but of weight, of all things, we are told of a balloon, though how this is connected to electric lighting the student has to guess. Then comes a table of metric measures and decimals to the sixth point before we have got to electricity at all. Moreover, not those units which are actually in use are given only at first—but all. Who uses the "myria-volt?" An "erg is the work done by pushing a body through a distance of 1cm. against an opposing force of one dyne." Interesting to a beginner in electric lighting! What is a "dyne"? and how is it used? might ask the student. Presently "joule" comes on the scene without explanation, save that it is ten million ergs. A whole page of equivalents follow—decimals to the tenth point—out of all of which at the bottom is the only thing that should be first learnt—viz., one watt $= \frac{1}{746}$ h.p. Then we are told 1,000 watts is the commercial unit, but we are not given its name, kilowatt—the student will no doubt guess this by combining the tables previously given. A short paragraph follows in abstract terms; and italicised words, *energy*, *force*, *work*, and *power*, are defined. Does the author think the elementary student will understand the whole mystery in 10 lines? And then follows 14 "examination" questions, such as: "Give in pounds the equivalent of an hektogramme. Define: Mass, Energy, Power, Weight, Work." Thus is the elementary student introduced to electric lighting and power. If he does not know it all before, he can hardly assimilate much in this way. Chapter II. deals with a multitude of matters—pressure, resistance, quantity, capacity, Board of Trade unit, Ohm's law. A table of conductors is given, from silver to bismuth, and oils to dry air. We are waiting for facts about electricity yet: soon we shall come to them, no doubt. Tables of conductivity and resistivity; then we have: "The specific resistivity of a substance is the resistance between opposite faces of a cm. cube of the substance expressed in microhms"—and we do not know what an "ohm" is yet! except that it is the "reverse of mho," and that "one microhm = one megmho." Current comes next, and is "measured in amperes." Suppose the elementary student does not know what an ampere is: he will find it is "one coulomb per second," and asking what is a coulomb, he will learn only it "has nothing to do with pressure." Two pages of Ohm's law, and then we come to capacity—electricity at rest. The elementary student of electric lighting now has his first taste of apparatus, and it is—what? A dynamo, lamp, wires? Oh, no! a tinfoil condenser and a Swinburne "electric light" condenser. Here we are getting to electric light, thinks the student. He might ask if this is the apparatus generally in use; and the answer that they were nearly unknown in practice would disconcert him. The hydraulic analogy comes in with a diagram; and the next paragraph defines the microfarad—33 pages and 24 questions—and we are well advanced in "electric light and power." Chapter III. deals with current, magnetism, lines of force, and solenoids—it is full of hydraulic analogies and "right and left hand rules" for finding direction of current (we don't know how to get a current yet). We are introduced to magnets—and solenoids, and some very useful forms of magnets for "electric lighting," an "iron-clad and annular iron-clads"! Then 18 more questions: "Give sketches of two iron-clad magnets," etc. Chapter IV.: Induction, electromagnetic induction, Lenz's law, self and mutual induction, hysteresis, questions. We now have an experiment—Faraday's fundamental experiment—the first, we think, in the book; it occurs one-third the way through. There are numerous paragraphs carefully numbered, with smaller paragraphs added (in the irritating fashion set by Thompson's "Elementary Lessons"), which make rather hard reading for an elementary student. Example (p. 71): "We find thus that $B = H\mu \therefore \mu = \frac{B}{H}$," and this, mind you, two pages after an experiment with soft-iron tacks. The student is expected after this to: "Show clearly the difference between magnetomotive force and magnetising force." We now come to Chapter V.: Measurements, standards, voltmeters, wattmeters, Kelvin balances. We have not yet seen a cell, or a dynamo—we do not, until the last chapter. But we measure; and the elementary student is given his Wheatstone bridge, ohmmeter, voltmeter, and electrostatic balances to his heart's content. A great deal of pains has been taken with this chapter, but it comes in the wrong place. We want our current generated before it is measured. Aron's, Teague's, and Thomson's meters are carefully and usefully described; and then we come to Chapter VI. and last—the dynamo. The principles here are clearly explained, good diagrams are given, the parts and actions of the dynamo are set forth practically and with good arrangement. Diagrams of different machines are given in bold drawing. This chapter shows more careful pre-considered thought than all the others. The preface says the proofs were read through by Mr. Swinburne, whose hints have been embodied. If he had suggested to the author that it would be well to reverse his chapters, it would have been a good thing for the typical elementary student. As it is, the book is certainly useful, but should be read, beginning at the last chapter and going backwards. In all that the author has said at the beginning he has had this last chapter in his mind. Why not let the student have it also?

SOME ECONOMIC POINTS IN CONNECTION WITH ELECTRICITY SUPPLY.*

BY GISBERT KAPP.

It is now about 10 years since electric lighting by means of incandescent lamps has come within the reach of the average well-to-do householder. Those who were the first to avail themselves of the new illuminant did so because they recognised its advantages and comforts, but the question of cost, and especially of working expenses, was in those days a secondary consideration.

It is true that 10 years ago, as now, a man who thought of having his house wired, and machinery installed for lighting, would begin by making enquiries as to what the installation would cost, and would perhaps invite estimates from various electric light firms, with a view of placing the order with the firm who submitted the lowest tender; but, beyond counting his first capital outlay, the question what the light would cost him year after year was either not considered at all, or if considered, could not be settled beforehand, because at that time there was no practical experience regarding the various items of expenditure which make up what we now understand by the term "annual working cost."

The heavy initial outlay for generating machinery tended at first to retard electric lighting, but when, after a few years central stations began to be erected, and householders could have current laid on in the same way as gas and water are laid on, the use of electric light developed with great rapidity. It would have developed still faster were it not for the initial outlay in wiring and fittings, which is still considerable. A householder who does not own his house is naturally reluctant to lay out for wires and fittings a sum amounting to from £1 to £2. 10s. or £3 per lamp, because he has no certainty that, in the event of his leaving the house, the next tenant would take these things over; but the difficulty is not nearly as serious as in the case of generating machinery, the outlay for which is much greater. It is also, as a rule, possible to make some arrangement with the landlord under which the latter pays part of the cost for wiring, the outgoing tenant being at liberty to take the fittings with him, if the incoming tenant refuses to take them over.

The establishment of central stations has, therefore, resulted in a great development of private electric lighting. It has, however, done more: it has led to a true appreciation of the cost of electric lighting. The householder knows what he spent on wiring and fittings, he knows what he has to write off annually to cover any possible loss in case he leaves the house, he knows what he pays for lamp renewals, and he knows, by his meter, what he has to pay for current. He can thus ascertain what each lamp installed costs him per annum, and those who take the trouble to keep accurate accounts generally find that the light is not nearly so expensive as they had at first supposed. In other words, the electric light, which, 10 years ago, was an expensive luxury, has, thanks to the establishment of central stations, now become a commodity obtainable at a moderate price, and, moreover, at a price which can be ascertained beforehand.

The cost of current is, as you know, fixed by the order under which the electric light company carry on their business, and it is a remarkable fact that most companies charge less than they are entitled to charge under their order. The present tendency of electric supply companies all over the country is to reduce their rates, and this shows that they possess no monopoly, even within the limits sanctioned by Act of Parliament. Some years ago there was an apprehension that the supply of electricity, like that of gas or water, might in time grow up to be a gigantic monopoly, but such a fear is groundless. Gas and water are commodities that, generally speaking, cannot be produced privately and on a small scale. A householder in town cannot erect on his own premises a waterworks or a gasworks, but he can easily put down his own electric light works, and thus make himself independent of the electric light company. Whether it will pay him to do so will depend principally on the amount of current he uses. A small user will find it very expensive, and a large user fairly cheap. The former could therefore afford to pay the maximum charge per Board of Trade unit which the Act permits, and be still better off than if he employed his own generating plant; but the latter will be able to generate his own electricity cheaper than that, and if the company desire his custom, they must supply him at a rate not much higher than the rate at which he could supply himself. Under these circumstances the company might wish to make a difference in their charges, according to the class of customer served. But this it cannot do. The Legislature has very wisely inserted a clause in the Act, compelling the supply company to charge all its customers precisely in the same way. The effect of this clause is that, in so far as the competition of a private generating plant may influence the charge, this influence is exerted by the large, and not by the small consumer. In other words, the large consumer protects the small consumer against any attempt on the part of the supply company to take an unfair advantage of their monopoly, even were the company so minded.

There exists, however, a far more general check against any monopolist tendencies in electric supply, and that is the fact that a cheap tariff means a large business, and that profit can only be made by an electric light company if its business is large. I have pointed out already, that where the supply is derived from a central station, the cost of electric lighting can be ascertained with great accuracy. With private installations this is not so easy, and is, in fact, very seldom done.

A person who wishes to introduce the electric light into his house, when the latter is not within reach of the mains of a supply company, invites tenders from various contracting firms, and places the order with the firm that sends in the lowest tender, or, if the difference is not very great, with the firm that has shown him the prettiest fittings, or is recommended by some friend who has had his house lighted by the same firm. The number, candle-power, and disposition of lamps, and the arrangement of machinery are left to the contractors, who, having done similar work before, are naturally supposed to know exactly what is wanted. They do know what is wanted, but they also know that several other firms are competing for the same work, and that a low quotation is likely to secure the order.

The principle on which tenders are invited is not to so design the installation that the requisite amount of light will be obtained at a minimum actual working cost, but at a minimum of capital outlay.

Once the plant is put down and satisfactorily started, the contractor has done his part of the work, and it is henceforth the owner's look out to run the installation. Any faults of design, tending to increase the working cost, constitute a continual source of loss, and if the money thus annually wasted be capitalised, it will generally be found to exceed the sum which, in the first instance, would have had to be expended in order to avoid the faults.

This economic principle has, of course, been fully recognised and followed by those engineers who have to design central stations, but it is generally disregarded by the contractors for private installations, who are forced by competition to aim rather at low first cost than economy in the long run.

It might, perhaps, be thought that, in such a matter as a private installation, there is no such scope for the combination of engineering and financial skill required to produce the best economic results in central-station work. Indeed, many electric light contractors have their designs cut and dried beforehand. An installation of so many lamps requires a gas-engine of a certain horse-power, a dynamo of a certain output, and a battery of a certain capacity. They know all this from previous experience, and see no reason for making any change, and the same plant is put down regardless of the special conditions in each case. I need hardly say that local condition should be very carefully taken into account when designing an installation, either large or small; and although I cannot attempt, in the short time at my disposal, to treat this subject at all exhaustively, I will endeavour to direct your attention to a few points which influence the economic working of the installation.

TIME OF LIGHTING.

If you ask the manufacturers of incandescent lamps at what voltage their lamps should be worked, they will tell you at the voltage for which the lamps are made. The lamps will then last from 1,000 to 1,500 hours. Yet it may be advantageous to run the lamps at a higher voltage. To put the case in as simple a way as possible, I will assume that we have to do with two country houses, each requiring a total of 100 16-c.p. lamps installed. Let the driving power be gas in both cases, and at the same price; but assume that one house is inhabited all the year round, and that each lamp is used for 500 hours annually. The other is inhabited only for a few months, and each lamp is used for 100 hours in the year. Let, further, the maximum number of lamps burning simultaneously be in each case such as to give an aggregate of 1,000 c.p. If we work the lamps in the first house at 4½ watts per candle, we shall require a battery capable of giving an output of 4½ kilowatts, and a gas-engine and dynamo to correspond. Each lamp will require renewal once in two years. Taking the lamps at 3s. 6d. each, the annual cost of lamp renewals would be under £9, whilst the interest and sinking fund in the generating plant taken at 8 per cent., would amount to about £60, and the cost of current, which we may roughly take at 6d. per unit, would amount to £87—total, £156.

The same plant, worked in the same way, could of course also be used in the other house. The lamp renewals would be only £2, the interest would remain the same, but the cost per unit would be slightly increased, because the items for repairs and labour would not be diminished proportionately to the output. Assuming an advance of 2d. per unit on this account, the expenditure would be as follows: Interest and lamp renewals, £62; cost of current, £23; total, £85. This, however, would not be the most economical way of lighting the house. We would do better to overrun the lamps, because then the same amount of light could be obtained with a smaller plant. Say we run the lamps at a higher voltage than fixed by the makers, so as to obtain a candle with three watts. The total power now required is a little over three kilowatts, and the cost of generating plant, instead of being £750 as formerly, would be reduced to about £550. The cost of repairs would be slightly less, but against this saving we may set off the fact that the smaller engine will use rather more gas per horse-power. The cost of labour will, of course, remain the same as before, so that we shall again have to reckon the current at 8d. per unit. But instead of using 700 units, we shall now only use 480 units, at a total cost of £16. The only item which has been increased is the lamp renewals. The higher we work the lamps the shorter will be their life, and the higher will be the lamp bill. To take an extreme case, let us assume that the lamps either break or become so blackened as to be unfit for use after half the time, as in the other case. The renewal bill will then increase from £2 to £4, and the total cost of lighting works out as follows:

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* Paper read at the Society of Arts on Wednesday, April 17, 1893.

Eight per cent. interest and sinking fund on £550 ...	£44
Current	16
Lamp renewals	4
	£64

a saving of £21 per annum, due to the fact that we are working the lamps at a voltage higher than that recommended by the makers. In this calculation of annual cost I have left out the item for interest and sinking fund on wiring and fittings, as this is not affected by the change in voltage.

COST OF POWER.

Another item which requires very careful consideration is the cost of power. When water power is available, and hydraulic works have to be erected specially for lighting purposes, we should naturally try to do with as little power as possible, so as to reduce capital outlay and maintenance of hydraulic works. But small power means a long daily charging period, and consequently a heavier labour bill than would be incurred were the plant sufficiently powerful to restrict the charging time to one or two days per week. The best design must obviously be a compromise between these conflicting conditions.

If the power is derived from steam, gas, or oil, the cost of fuel is of material importance in designing the plant. Let us suppose that gas is the motive power, and let us again compare two houses, each requiring 100 16-c.p. lamps, the lighting time to be the same in both houses, but the price of gas in one case to be 2s. and in the other 4s. per 1,000 cubic feet. In the house supplied with cheap gas, we work the lamps at 4½ watts per candle, and consume annually 3,500 units. For a small installation, worked with cheap labour and indifferent supervision, we cannot hope to do better than about 80 cubic feet of gas per unit delivered to the lamps. This brings the bill for gas and lamp renewals to £37. If the same plant be installed in the house where gas costs 4s., and worked in the same way, the corresponding item would amount to £65. Suppose, however, we work the lamps at three watts per candle, then we should only consume 2,400 units, and a smaller plant would suffice. The smaller engine would use about 90 cubic feet per unit, making the gas bill £43. The renewal of lamps would now cost twice as much as before—namely, £18—bringing the cost of these two items to £61, or slightly less than when the lamps are worked at their normal voltage. This calculation is based on the price of 3s. 6d. per lamp. There is, however, good reason to anticipate a large reduction in the price of lamps after the lapse of the Edison patent, and the lower the price of lamps the greater is the economic advantage in overrunning the lamps. This is a point which contractors for private installations would do well to consider. With lamps at 1s. 6d. each, it would pay to run at something like 2½ watts per candle, and this would mean a reduction of about one-third in the capital outlay for generating plant, and a material reduction in working expenses.

CAPACITY OF PLANT.

In private installations worked by gas-engines, the cost of gas is generally found to be the heaviest item amongst the list of engine-room expenses, and, in this connection, it is instructive to notice the difference between the theoretical and actual performances of the engine. Gas-engine makers are always telling us that a brake horse-power hour can be obtained with something like 30 cubic feet in small and 20 cubic feet in large engines, and, as a matter of fact, these results are obtained on a full-load test. With a dynamo of 85 per cent. efficiency, and an engine consuming 30 cubic feet per brake horse-power hour, we should obtain the unit at the dynamo terminals for 47 cubic feet, and from the battery, for 67 cubic feet, assuming the battery to have 70 per cent. efficiency.

These results are, however, not actually obtained in small installations. The reason is that the gas-engine is, as a rule, worked much below its power, or, in other words, that the battery is too small. Since batteries are expensive items, costing between £40 and £50 per kilowatt output, it is natural to cut down the battery power to the lowest possible limit, but it is not true economy. A small battery means not only lower efficiency of the battery itself, but more maintenance, longer running hours for the engine at small loads, and consequently waste of gas. The cost of attendance is, of course, also increased.

(To be continued.)

A NEW FORM OF PORTABLE PHOTOMETER.*

BY SIR DAVID SALOMONS, BART., M.A., VICE-PRESIDENT.

If two nicol prisms be mounted in a tube, and a source of light is observed through them, then the amount of light which will reach the eye is governed by a well-known law depending on the relative positions of the prisms to one another. The quantity of light passing depends upon a function of the angle which the polarising plane of the polarising prism makes with the polarising plane of the analyser: and since one-half of the light issuing from the source of illumination observed will never reach the eye—*i.e.*, the ordinary ray which is thrown out by the polariser—the light which reaches the eye will be half the original light multiplied by a function of the angle included between the polarising planes of the two nicols. This function is the square of the cosine of the angle included between the two planes mentioned, consequently the quantity of light reaching the eye from a given source will be governed by the well-known formula as follows:

Let I = intensity of the light observed,
,, L = light which reaches the eye,
,, O = ordinary ray in polariser,
,, E = extraordinary ray in polariser,
,, θ = angle between the planes of polarisation of polariser and analyser,

the light which reaches the analyser is E, or $\frac{I}{2}$, since $O = E$ and $I = O + E$.

The amount of light which reaches the eye is expressed by the equation

$$L=\cos^2\theta\, E, \text{ or } L=\tfrac{1}{2}\cos^2\theta\, I;$$

hence L varies as $\cos^2\theta$.

In this instrument two tubes are mounted as a binocular capable of being adjusted for distance apart, in order to suit the eyes of different individuals, and the hinge portion used for such adjustment is made without a stop, so that the position of the tubes may be reversed in its relation to the eyes. Each of these tubes contains two nicols, arranged as usual, but instead of the analyser being revolved the polariser is capable of being turned. The polarising plane of the analyser is set at 45deg. from the vertical in order to obtain the scales in a convenient position upon the tubes.

Consider for a moment one of the tubes—a description of which applies to the second. The polariser is so mounted that its position is indicated upon two scales at the same time; the one being graduated in degrees to be used for accurate work, and the other graduated in divisions indicating what proportion of the light observed will reach the eye. One scale is called the "degree scale," and the other the "light proportion scale." The latter scale is so graduated that it reads unity for the "light field," and zero for the "dark field." The intermediate division numbers are 0·1, 0·2, and so on. This scale is used for approximate measurement.

When the "light proportion scale" reads unity the "degree scale" indicates 0deg., and when the former shows zero the latter scale reads 90deg.

The method of determining the positions of the divisions:

We have $$L = \tfrac{1}{2}\cos^2\theta\, I = \cos^2\theta\,\frac{I}{2}.$$

Now equate $$\mathrm{Cos}^2\,\theta=0{\cdot}1$$ $$\mathrm{Cos}^2\,\theta=0{\cdot}2 \text{ and so on.}$$

Solve each equation, and the values of the angles so found are the successive points on the scale required. The following table gives the angles by working to three decimal places in making the calculation:

Divisions upon the "light proportion scale."	θ	
0	90deg.	no light passes.
0·1	71deg. 26′	
0·2	63deg. 34′	
0·3	56deg. 13′	
0·4	50deg. 14′	
0·5	45deg.	
0·6	39deg. 36′	
0·7	33deg. 47′	
0·8	26deg. 26′	
0·9	18deg. 34′	
1·0	0deg.	maximum light passes.

If the values for $\cos^2\theta$ for the right-hand and left-hand tubes are A and A', and the values of the lights observed with the right and left tubes are I and I'.

Since the photometer is balanced at the start, each eye receives the same amount of light, it is therefore correct to equate $L = A\frac{I}{2}$ and $L = A'\frac{I'}{2}$. It is evident the result will remain unaltered if we regard these equations as $L = A\,I$ and $L = A'\,I'$, and it will save the observer the trouble of doubling the final result.

In front of the polariser a small round opal, or some equivalent, screen is placed, and the light upon this screen is that which is directly to be observed. The screen is mounted in a cell and screwed on the end of the tube. A lens is inserted in the tube to focus this screen upon the retina. This screen may be removed.

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* Paper read before the Institution of Electrical Engineers.

When desired, an adjustable lens may be added in front of the observation tube to focus the light in the plane of the screen. In some cases this may be convenient.

To make an observation with this instrument it is placed before the eyes in the same way as a field glass, each polariser having been turned to the position of "light field," when the "degree scale" will indicate zero degrees, and the "light proportion scale" will read 1. One tube is now directed towards the source of light under examination, and the other tube towards some known standard radiant. The distance of the light under observation, and the distance of the radiant from their respective screens (which are before the polarisers) are measured. Then, according to the usual methods of photometric measurement, assuming that the source of light under observation cannot be moved, it would be necessary to shift the standard radiant in order to get a balance—*i.e.*, to render the screen, observed by each eye, illuminated at the same intensity. Instead of shifting the standard radiant, the balance with this instrument is obtained by revolving the polariser, which faces the brighter screen (should any difference exist) in order to reduce the illumination of both screens to the same apparent intensity. The value of the light under investigation in terms of the standard may be calculated when the amount of light cut off by the polariser, the distances of the two sources of illumination in question, and the value of the standard illuminant, are known.

It should be again observed that, since the ordinary ray reaches neither eye, it is equivalent to an equation, each side of which is divided by 2; and consequently the final result will be the same as if no such division by 2 existed.

To make such an instrument thoroughly practical several mechanical appliances are needed, and exist in this instrument. It will be a convenience if the standard radiant can be placed always at such a distance that the square of this distance shall be unity; and instead of this radiant being in front of the instrument—which would cause it to shed light on the other screen, or be in the way—it should be placed at the side, and illuminate its screen by means of a right-angled reflecting prism, and the arrangement is such in this apparatus.

The comparison radiant for this instrument consists of a standard candle contained in a tube; the candle being fed up by means of a spring, the top of the tube forming an abutment to keep the candle flame at one level, although the length of the candle is always altering. This abutment piece is surrounded by a cup to catch any grease which may run over. The candle-tube has a slot cut in it, in order that the amount of candle in the tube may be observed at any moment. The candle-tube is carried in a light framework, which supports a metal cylinder that acts as a chimney to keep off draughts. This chimney has in it a small window, into which slides a slip of clear glass, and it is through this window that the light from the candle passes to illuminate its screen. The clear glass may be replaced by tinted glass when desired.

The chimney is carried in a special form of gimbals, so that no matter what inclination may be given to the binocular, the candle will always remain vertical, since the gimbals are attached to the binocular by means of an arm. The inner ring of the gimbals is in reality only half a ring, and the plane of the outer ring when the candle is vertical, instead of being at right angles to the axis of the candle, is oblique to its axis. This construction is necessary, otherwise the rings would come before the window in the chimney and so obstruct the light. In front of this window is placed a suitable-shaped tube, capable of being lengthened and shortened if required, and which fills up the space between this window and the reflecting prism; this prism being situated in front of the screen at the end of the tube containing the nicols. The object to be secured is that extraneous light should be kept from this screen. The weight of this adjusting tube is counterpoised so that the candle may always remain vertical. The arm connecting the candle with all its supplementary apparatus is carried upon its observation tube (which contains the nicols) by means of a ring arranged in such a way that, although removable, it cannot turn except to a small degree by means of an automatic motion. The reflecting prism also is carried in a similar way. The arm has two motions upon it—one a clamping joint to enable the candle flame to be brought in front of the prism to a nicety, and the other a kind of parallel motion arrangement by which the candle can be placed to two given distances from the prism, according as to the parallel arrangement (somewhat similar to a parallel ruler) is pushed to the one side or to the other. The measurements and the arrangements of the details are all so adjusted that the candle flame will always be facing the reflecting prism for all inclinations of the binocular, and the two distances to which the candle may be moved are so regulated that the apparent distances of the flame from the screen it illuminates shall be either the square root of 10 or the square root of 12. These two distances are the most convenient, one for use when measuring by a decimal system, and the other when measurements are made in feet.

It may be mentioned that the candle arrangement with its arm can be removed at pleasure, so also can the reflecting prism. It will be noticed that the weight of the candle with its apparatus tends to twist the ring round upon the tube containing the nicols, and it might appear that this could be avoided by simply cutting a slot in the ring to push over a pin screwed into the nicol-tube. This, however, is not feasible, for, in order always to have the relative positions of all parts as they should be, it is essential that the ring, which carries the candle and its arm, should have a slight circular motion. This is obtained by placing upon the direct observation nicol-tube another ring, which is connected with the candle-arm ring by means of a slotted sliding bar in such a way that the candle apparatus cannot be displaced and the relative positions are always correctly maintained.

A description of this part, simple as it is, would be complex, so that references must be made to the plates attached hereto, by the inspection of which the arrangement will appear clear. The eyes of any one person differ, so that an observation error is sure to be introduced. In order to eliminate this error, the instrument is so arranged that the relative positions of the parts of the instrument can be reversed when a second observation is taken, which is equivalent to an observation with the eyes reversed. A mean of the two observations is then taken. The instrument described has this particular advantage not possessed by other photometers.

At starting, it is only necessary to place the candle in its fittings on any of the photometers in general use, in order to ascertain the standard value of the light which issues from the window and from the tube when the latter is used. These two values, which may practically be considered as constants, can be engraved upon the chimney. The loss of light due to the reflecting prism may be ascertained at the same time.

When it is desired to put the instrument (set up and the candle alight) upon a table, it is placed upon a small slender tripod. This tripod, which can be closed to render it portable, accompanies the instrument. It may often be found convenient, when using this apparatus, to place it upon a tripod after the same manner as a theodolite.

This photometer packs up into a sling case barely larger than those used for field glasses.

Some of the advantages derived from this instrument may be stated as follows: Very powerful arc lights may easily be compared with one another or with a standard source of light It may be used for measuring various sources of light, such as daylight out of doors with light in a room, and for the estimating of photographic exposures. That the instrument is exceedingly convenient, compact, portable, and easy to use, need scarcely be stated. It may also be employed for rapidly comparing the light in one or more places far apart, which is frequently a great convenience.

Two points alone might be urged against the principle. The first is that nicol prisms are not, as a rule, sufficiently accurate for very close measurements. However, to make these prisms quite accurate, or at any rate sufficiently so for this purpose, is no difficult matter, as may easily be proved by taking a number of nicol prisms at random and testing them. Secondly, errors are introduced due to internal reflections as well as reflections which take place at the surfaces of the prisms. These losses occur for the nicols in both tubes, and when the losses in each tube are deducted from one another for any positions of the nicols, the difference will be found to be so small as to affect, to an inappreciable extent, the result.

The nicol prisms in the tubes might be dispensed with and be replaced by adjustable diaphragms somewhat similar to the "Iris" pattern, one being placed in each tube and an index scale showing the area, which is free, for the light to pass; as well as a proportion scale for reading the quantity of light which passes without calculation. The principle, of course, would remain the same as that already described.

Again, it might be possible to vary the proportion of light passing down the tubes by wedges of tinted glass; but on the whole the nicols appear to present so many advantages that a preference was given to their use.

Appended hereto are the formulæ applicable to this apparatus for general work, and it will be unnecessary to refer to any tables or to make tedious calculations, excepting in those cases where great accuracy is required, in which event the scale of degrees must be used, and the values of the cosines be looked out and squared.

Let X = the light under examination,
,, l = the comparison light expressed in standard candles,
,, D = the distance in inches of X from the screen of the photometer facing X,
,, d = the distance in inches of l from the screen of the photometer facing l,
,, θ = the angle between the polarising planes of the nicols in the tube facing X,
,, θ' = the angle between the polarising planes of the nicols in the tube facing l,

then
$$\cos^2\theta\,\frac{X}{D^2}=\cos^2\theta'\,\frac{l}{d^2},$$

and
$$X=\frac{\cos^2\theta'\,D^2}{\cos^2\theta\,d^2}\,l.$$

Let
$$\cos^2\theta=A \text{ and } \cos^2\theta'=A$$

then
$$X=\frac{A'}{A}\;\frac{D^2}{d^2}\,l.$$

In this photometer d may be made $\sqrt{10}$ or $\sqrt{12}$, so that th last equation may be written

$$X=\frac{A'}{A}\cdot\frac{D^2}{10}\,l, \text{ or } \frac{A'}{A}\cdot\frac{D^2}{12}\,l,$$

according to the value of d.

If D is divided by 12 the distance will be expressed in feet.

Let
$$\frac{D}{12}=D|,$$

then
$$X=\frac{A'}{A}\;\frac{D^2}{12}\,l \quad . \quad . \quad . \quad . \quad (1)$$

when distances are given in inches,

and

$$X = \frac{A' D'^2 l}{A} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$

when distances are expressed in feet.

When the values of A and A′ are calculated from the "degree scale," certain special cases occur which simplify the equations. They are when $\theta = 0$deg., $\theta' = 0$deg., $\theta = \theta' = 0$deg., $\theta = 45$deg., and when $\theta' = 45$deg. In these cases A and A′ will become unity for 0deg. and ½ for 45deg.

With most observations the value of A' will be 1, and equations (1) and (2) will then become

$$X = \frac{D^2 l}{10\ A} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \quad (3)$$

and

$$X = \frac{D'^2 l}{A} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \quad (4)$$

When the values of A and A′ are obtained from the "light proportion scale," the values are in decimals of one place, so that these figures made be read as whole numbers multiplied by 0·1.

Equations (3) and (4) may then be writen—

$$X = \frac{D^2 l}{10\ A \times 0{\cdot}1} = \frac{D^2 l}{A} \quad . \ . \ . \ . \ . \ . \ . \quad (5)$$

and

$$X = \frac{D'^2 l}{A \times 0{\cdot}1} = \frac{10\ D'^2 l}{A} \quad . \ . \ . \ . \ . \ . \quad (6)$$

Putting these equations into words :

Rule 1.—When only the light under observation is reduced by turning the polariser, the "light proportion scale" is used, and the distance of this light from the screen is given in inches, then the square of this distance, multiplied by the standard comparison light in candles, and this product, divided by the reading on the "light proportion scale" (read as a whole number), gives the value in standard candles of the light observed.

Rule 2.—When only the light under observation is reduced by turning the polariser, the "light proportion scale" is used, and the distance of this light from the screen is given in feet, then the square of this distance, multiplied by 10, and by the standard comparison light in candles, and the products divided by the reading on the "light proportion scale" (read as a whole number) gives the value in standard candles of the light observed.

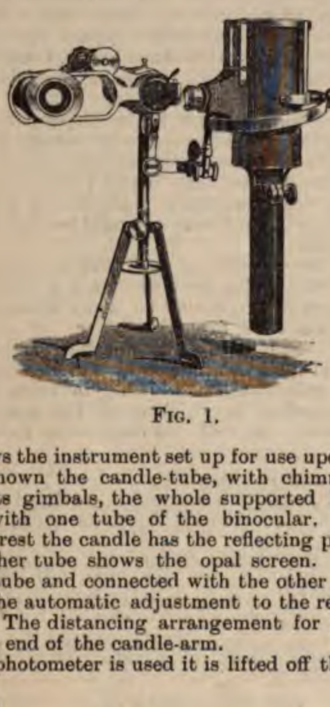

FIG. 1.

Fig. 1 shows the instrument set up for use upon the tripod. On the right is shown the candle-tube, with chimney and screening tube, set in its gimbals, the whole supported by the arm which connects it with one tube of the binocular. The tube of the binocular nearest the candle has the reflecting prism upon it. The end of the other tube shows the opal screen. The long link embracing this tube and connected with the other one, is the portion which gives the automatic adjustment to the reflecting prism and candle-arm. The distancing arrangement for the candle is seen at right-hand end of the candle-arm.

When the photometer is used it is lifted off the tripod.

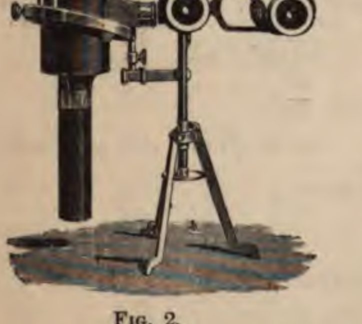

FIG. 2.

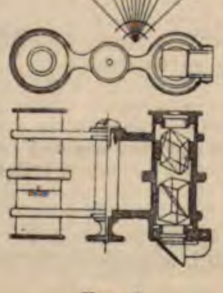

FIG. 3.

Fig. 2 is the reverse view of the last one, and shows the appearance of the instrument as seen from the side which faces the eyes.

Fig. 3 shows the arrangement of the binocular portion of the photometer diagrammatically. At the top is shown the scale of divisions of the "light proportion scale." In the centre the end view of binocular is illustrated, showing on one tube a screen, and on the other tube the reflecting prism covering its screen.

The lower diagram is a side view. On the left tube is seen one scale, the second one is on the other side. The centre portion is the hinge with a clamping nut, and the right tube is shown in section, with the reflecting prism attached.

TIVERTON.

The following report by the borough surveyor, Mr. J. Siddalls, has been presented to the Town Council :

In accordance with your instructions to prepare an estimate of the cost of carrying out the works for the supply of electric energy in the borough, and the expense of future maintenance, I have the honour to present the following report.

As the subject of electric lighting has been under consideration for some considerable time, it no doubt will be advisable, in order to make this report as complete as possible, to briefly state the steps that have already been taken in the matter. The question was first brought under the consideration of the Council in October, 1889, by the receipt of a notice from the Devon and Cornwall Electricity Supply Company that it was their intention to apply to the Board of Trade for a provisional order for the supply of electrical energy within the borough ; when the Council, after full discussion of the matter, decided that it would not be prudent to allow an outside company to obtain such extensive and far-reaching powers, including, practically, a monopoly of the supply of electric lighting for a period of 42 years, and they therefore unanimously resolved to oppose the application of the company ; and further, to apply for a provisional order themselves, so as to prevent any other company or person from acquiring rights which might prejudicially affect the interests of the borough.

A committee was appointed to take the necessary steps to obtain the provisional order, and to make full enquiries, and report as to the best method of carrying into effect the duties imposed upon the Council by the order. In regard to the first part of this instruction, application was made to the Board of Trade, and after considerable correspondence and an interview between the heads of the Department and the town clerk and myself, the provisional order was granted in August, 1890. The provisional order imposes, *inter alia*, upon the Council the following duties : to lay down, within two years from the date of the order, distributing mains for the purposes of general supply throughout the compulsory lighting area, as shown on map deposited with the Board of Trade. The charge authorised by the order is 8d. per unit.

In connection with the second portion of the Council's instruction to the committee, I was requested to visit various typical electric lighting stations in London and other towns, and to obtain such particulars as would enable the committee to make a recommendation to the Council on the subject. The results of my visits and enquiries were incorporated in my report dated October, 1891, where statistics are given to the progress of electric lighting in London and the provinces, with observations as to mode of working, systems adopted, etc. In concluding that report, I made certain recommendations which were approved by the committee and referred to the Council—viz.: (1) for the present, not to undertake the lighting of the town themselves ; (2) to advertise for offers from persons or companies to undertake the powers of the provisional order for a specified term, with the power of purchase by the Council at the end of the term.

The Council fully discussed this matter on October 7th and November 4th, 1891, and, while not committing themselves to any specified course, instructed the committee to carry out the second recommendation. Advertisements were then inserted in the London electrical journals and provincial papers, but the result was disappointing. A considerable amount of correspondence ensued between various companies and myself, but no offers were received. The committee were engaged in their endeavours to obtain offers from companies under the conditions laid down until April, 1892.

During 1890 and 1891 I made repeated surveys of the River Exe, from Thorverton to Cove, with a view to selecting the most suitable position for a station, in the event of water being selected as the motive power, and, after taking levels, I came to the conclusion that a site near the sewage farm would answer the required conditions better than any other within a reasonable distance of the town. In May, 1892, I laid my plans before the committee, when the following resolutions were passed : (*a*) "That the surveyor be empowered to engage an expert to give an opinion on the question of the water power of the River Exe." (*b*) "That the information obtained by the surveyor, and the plans he had prepared, with the opinion of the water engineer, be laid before various lighting companies with the view to ascertain if they would be willing to undertake the powers of the provisional order with the fresh information now obtained ; failing their doing so, the surveyor to obtain prices and particulars to enable him to estimate the cost of carrying out the work, and the expense of future maintenance."

In accordance with these instructions, the services of Mr. Frank Christy, of Chelmsford, were engaged as an expert in hydraulic engineering, whose report, which confirms my figures and conclusions, is appended hereto. After the receipt of this report, and the preparation of plans of the town showing method of present lighting, compulsory and optional areas of supply under the provisional order, plans of water-power works, and other local particulars, I made another effort to carry out the wishes of the Council by laying this information before various leading electrical engineering companies; but the companies, after full consideration of the matter, one and all declined to make an offer to the Council, stating that the business was outside their legitimate operations as contractors for electrical plant, and that as a local authority was in a position to borrow money at a much lower rate of interest than either they or any local company they might form could do, it would be much to the advantage of the Council to carry out the works themselves. I then proceeded to obtain the information requisite to enable me to carry out the last portion of my instructions, to prepare an estimate of the probable cost of the Council undertaking the work themselves, and in connection with this part of my work I have to acknowledge with gratitude valuable advice and assistance rendered to me by the following gentlemen: Mr. S. Z. de Ferranti, London; Mr. W. M. Mordey, of the Brush Electrical Engineering Company; Mr. D. O. Bate (Messrs. Laing, Wharton, and Down); Mr. O. H. Baldwin (Westinghouse Electrical Engineering Company); Mr. W. H. Trentham (Woodhouse and Rawson); Mr. F. King (Electrical Power Storage Company)—who, in every case, gave me ready and valuable information on every point.

After full enquiry, and a close study of the subject, I have arrived at certain conclusions as to the scheme which, in my judgment, would be most suited for this town. Briefly stated they are as follows:

System.—I have given much time and thought to the question as to which system of supply would be most adapted to our requirements, and am more fully convinced than ever of the correctness of the opinion I gave in my report of October, 1891, that "the high-pressure alternating-current system is the one more likely to be found best for the requirements of this town." It is, therefore, on this system I have based my estimate, as it is equally suitable whether steam or water be the motive power, or whether the site of the lighting station be in the town or some miles away. At the same time, I would not wish entirely to exclude the low-pressure continuous-current system from consideration, as it is possible an electrical contractor may be able to suggest a scheme for lighting on that system which would be of advantage to the town. There are undoubted advantages in the low-tension system, which were pointed out in my first report, and the success of many stations run on the system cannot be questioned from an engineering or commercial point of view; but these stations are chiefly found in large and densely-populated towns.

Distribution.—In case the water power is utilised at the site before mentioned, the high-tension current would be carried on poles from the station to Little Silver, and from this point the wires would be laid underground throughout the town, the distribution in the town being on the same lines whether water power or steam is adopted. The high-tension feeder mains (carrying a current of 2,000 volts intensity) would be carried through St. Andrew-street, Fore-street, Gold-street, Station-road, Bampton-street, Newport-street, St. Peter-street, Angel-hill, Bridge-street, and West-exe North and South, communicating with transformers in the Town Hall basement and at other suitable points, from which low-tension mains, carrying a current of 100 volts, would be laid, from which the supply for the public and private incandescent lighting would be taken. This system would combine all the advantages of both high and low tension systems, and the distribution to private consumers would be unattended with any risk or danger.

Public Lighting.—The lighting of the main streets would be effected solely by means of arc lamps of 1,000 c.p. to 1,200 c.p., fixed at the most suitable points in the main streets. The side streets would be lighted by 32-c.p. incandescent lamps, and the courts by 16-c.p. lamps. The arc lamps would be run from sunset to 12 o'clock each night, and then extinguished, and a 32 c.p. incandescent lamp switched on for the rest of the night. The ordinary street lamps and lamps in courts would run all night. I have estimated that the town would be well lighted by the following lamps:

	Total c.p.
15 arc lamps, giving, say, 1,000 c.p. each	15,000
100 32-c.p. incandescent lamps	3,200
60 16-c.p. " "	960
	19,160

The present gas lighting being of the following nominal candle-power:

	Total c.p.
18 Bray's lamps, giving 60 c.p. each	1,080
164 ordinary lamps, giving 15 c.p. each	2,460
	3,540

Private Lighting.—The lighting of shops and houses for private consumers would be by means of incandescent lamps of various sizes as may be required, but for the purposes of estimating, I have adopted the most usual size of 8 c.p. as a standard.

Units of Power.—One of the most important considerations in laying down an installation for town supply is the most suitable size of the units of machinery for generating the electricity—that is to say, the capacity of the dynamos must be such as to prove the most economical in working, with a due regard for probable future extension. If, on the one hand, the standard capacity be too large, there will be a waste of power when the machine is only required for a small load or output; while it it be too small, there will be an additional expense entailed by extra supervision. Bearing these points in view, I have taken as a standard the capacity of a 60-kilowatt dynamo, and purpose to instal two of these machines to commence with—one for working and one spare machine in case of repairs, etc. The capacity of this size machine would be equal to running, in addition to the public lighting, 1,250 8-c.p. incandescent lamps for private lighting, and would require 100 h.p., either steam or water power, to drive it. It is upon this margin of 1,250 8-c.p. lamps running, which is equivalent to 2,000 lamps wired (it being found in practice that of the number of lamps wired not more than 60 per cent. are alight at the same time), that I have based my estimate (No. 1) for the installation at the commencement. I have also prepared an estimate (No. 2) for the plant and running when the requirements of the station necessitate another 60-kilowatt unit being laid down, which would give a total output, in addition to the public lighting, equal to running 3,000 8-c.p. lamps, or 4,000 lamps wired, and would require 200-h.p. engines or turbines for working the same. This maximum amount of private lighting may be reached in, say, six to ten years.

Power.—I have gone thoroughly into the subject of the most suitable power, and have considered the relative merits of gas-engines, steam, and water power. In regard to gas-engines, I do not find that at present they can be used with advantage in this case. Steam power is usually employed for the purpose, and I have worked out the cost of an installation of steam machinery. Water power, however, where available, presents so many advantages over every other, that, in my opinion, no effort should be spared to obtain such a power. As before indicated, a suitable site may be found on the River Exe, near the sewage farm, at a point one mile below Little Silver, particulars as to works in connection with which will be found in Mr. Christy's report. Although the permanent works are of a more expensive character in the case of water power, yet the annual saving in coal, repairs, and attendance much more than compensates for the greater first cost, as will be seen by a reference to the estimates. It is, however, most important to ascertain whether there is a certainty of sufficient power being available for running the installation during the longest winter nights, as well as what I consider more difficult, for the short nights in the dry months of the year. In regard to the requirements of power for estimate No. 1, which will only reach a maximum of 100 h.p. for about two hours per night in the winter, I do not see any reason to doubt that this will be attained at all times without difficulty, as in the winter, when the demand would reach the highest point, the water power would be at its best, and in the summer time, when water is low, the demand for the first few years will be low also. It is in regard to the maximum power required after the extension of the works that the closest consideration is demanded, and here the conclusions arrived at by Mr. Christy may be referred to. He does not apprehend any difficulty with regard to the short water in the summer, but considers there may be a difficulty after a 10 or 12 days' frost. Now fortunately in regard to this point, there did occur a long frost just at the darkest part of last winter, in December and January, and after it had lasted a fortnight, and just before it broke up, I was able to gauge the water flowing down the River Exe, when I found the stream to exceed 10,000 cubic feet per minute at the West-exe Mills; to this must be added the volume of the River Lowman, say, 1,000ft. I requested Mr. Christy to give me his opinion on these figures, which he did in these words: "The quantity of 10,000ft. per minute is quite sufficient for all that has been suggested so far, as the amount of the storage you will have will easily help you over the peak of your load diagram, at least up to 4,000 8-c.p. private lamps wired." At the same time, I think it may be possible that in the future it will be necessary to provide some form of supplemental power, which may be either as Mr. Christy suggests, by means of a Dowson gas generator and plant, or the turbines may be run all day pumping up water to a high-level reservoir on the adjacent hills, say, 400ft. above the side of the station, and the water used at high pressure during the hours of maximum load. This scheme, which I will designate a hydraulic accumulator system, would be sufficient for all future demands for power, however large the town may grow. However, seeing that no extra power will be needed until the demand for light increases to such an extent as to make it profitable to provide such a supplemental scheme (when the extra revenue will warrant the increased expenditure), it is not worth while to consider the question for the present further than to be satisfied of its practicability from an engineering point of view, before becoming committed to the site of the proposed station.

I have now to lay before you the estimates I have prepared based on the foregoing considerations.

Estimate 1.

Capital outlay for a station to supply public lighting and 2,000 8-c.p. lamps wired.

Water Power.

Leat and weir	£2,080
Buildings	1,500
Turbines and shafting	850
Land, law charges, and incidentals	1,020
	5,450
Overhead mains	760
Dynamos	1,200
Switchboards	220
Underground mains	3,930
Transformers, etc.	550
Public lamps	620
Legal expenses, provisional order, supervision of works, etc.	1,010
	£13,740

Steam Power.

Two engines and boilers	£1,800
Pumps, pipes, etc.	500
Alterations to building and erecting chimney	340
	2,640
Dynamos	1,200
Switchboards	220
Underground mains	3,930
Transformers, etc.	550
Public lamps	620
Legal expenses, provisional order, supervision of works, etc.	1,010
	£10,170

ESTIMATE 2.

Capital outlay for a station to supply public lighting and 4,000 8-c.p. lamps wired.

Water Power.

As per estimate 1	£5,450
Additional turbine	350
Dowson gas plant	1,200
	7,000
Overhead mains	980
Dynamos	1,780
Switchboards	320
Underground mains	4,360
Transformers, etc.	1,010
Public lamps	620
Legal expenses, provisional order, supervision of works, etc.	1,010
	£17,080

Steam Power.

As per estimate 1	£2,640
Additional engine and boiler	900
	3,540
Dynamos	1,780
Switchboards	320
Underground mains	4 360
Transformers, etc.	1,010
Public lamps	620
Legal expenses, provisional order, supervision of works, etc.	1,010
	£12,640

ESTIMATE 1A.—Annual Maintenance and Revenue.

Water Power.

Maintenance—Salaries and wages	£560
Oil, waste, etc.	30
Public lamp renewals	90
	680
Sundries, rates, etc.	50
Depreciation 7½ per cent. on dynamos and running plant, 5 per cent. on turbines, 4 per cent. on mains, conduits, and lamps, 2 per cent. on buildings, leat, and weir	400
Repayment of loan, £13,740, in 40 years, at 3¼ per cent. Annual instalment and interest	570
	£1,700
Revenue—Public lighting, say	£800
2,000 8-c.p. lamps, earning 10s. each	1,000
	£1,800

Steam Power.

Maintenance—Salaries and wages	£660
Oil, waste, etc.	65
Public lamp renewals	90
	815
Sundries, rates, etc.	50
Coal	570
Depreciation	480
Repayment of loan, £10,170 in 40 years	425
	2,349
Revenue—Public lighting, say	£800
2,000 8-cp. lamps, earning 10s. each	1,000
	£1,800

ESTIMATE 2A.—Annual Maintenance and Revenue.

Water Power.

Maintenance—Salaries and wages	£610
Oil, waste, etc.	40
Public lamp renewals	90
	740
Sundries, rates, etc.	50
Depreciation	550
Repayment of loan, £17,080	710
	£2,050
Revenue—Public lighting, say	£800
4,000 8-c.p. lamps, earning 10s. each	2,000
	£2,800

Steam Power.

Maintenance—Salaries and wages	£710
Oil, waste, etc.	90
Public lamp renewals	90
	890
Sundries, rates, etc.	50
Coal	750
Depreciation	626
Repayment of loan	526
	£2,842
Revenue—Public lighting, say	£800
4,000 8-c.p. lamps, earning 10s. each	2,000
	£2,800

Cost to Consumers.—It will be noticed that I have included in my estimates a revenue of £800 a year from public lighting, and considering the great increase of the lighting power, an additional charge of 20 per cent. would not be unreasonable, and this charge could be, and no doubt would be, lowered considerably when the undertaking reached the profit-paying stage; indeed, the profits might be employed in several ways—viz., in lowering the charge for public lighting, in reducing the charge to consumers, or in assisting the district rate. In regard to the charge for private lighting, which is a point that will be especially interesting to probable consumers, the charge of 8d. per unit is the maximum allowed by the provisional order. Now the term unit is one that it is hopeless to attempt to explain to the non-technical mind; indeed, the explanation of the term given in the order is the most bewildering clause in the whole document. I can best make it understood by saying that it is a quantity of electricity which, measured by its relative cost, bears to the cost of 1,000 cubic feet of gas about the ratio of 1 to 8—that is to say, electricity at 8d. per unit is equal as regards cost to gas at 5s. 4d. per 1,000, 7d. per unit to gas at 4s. 8d. per 1,000, 6d. per unit to gas at 4s. per 1,000, and so on, for the same lighting hours and same candle-power. My estimate as to revenue, it will be seen, is based on each 8-c.p. lamp earning (or charged to consumer at) 10s. per annum, which represents an average charge of 6d. per unit, so that the average customer who will be content to have his house or shop lighted with electricity of the same candle-power as gas, the lamps burning precisely the same number of hours, will pay the same as if the gas now cost him 4s. per 1,000. The cost of the installation will average 25s. per lamp, with lamps of a plain description; of course lamps of a more expensive character will add to the cost, though the wiring will be the same. The patent of the incandescent lamps runs out this year, and the price of them, which has hitherto been a serious item of expenditure, will be reduced to about one-third the present cost for plain pattern lamps.

In conclusion, I may say that I have endeavoured to lay the subject before you in such a way as to be readily understood, and I need not therefore, I think, apologise for the absence of technical and scientific terms, although, in justice to myself, I may state that all the figures given have been arrived at after close calculation according to the proper scientific formulæ.

COMPANIES' MEETINGS.

TELEPHONE COMPANY OF EGYPT.

The ordinary general meeting of this Company was held last week at the offices, Austinfriars, General Alexander Fraser, C.B., presiding.

The **Chairman** stated that it was unnecessary for him to go into any details respecting the irregularity which had taken place at Cairo beyond saying that Mr. Begni, their representative, had disappeared from Egypt. The Directors were therefore prevented from taking any criminal proceedings against him, and they had felt bound to write off the loss stated in the report. They afterwards sent their secretary to Eygpt in order to investigate matters. Mr. Chalmers was there for a month, and his visit had been attended by very satisfactory results. The Board had been able, in consequence of the information they had received from Mr. Chalmers, to put the management upon what he hoped would be a sounder basis by the introduction of new blood, and certain safeguards had been introduced with respect to the local control of the business. The secretary had also suggested improvements in the construction of the works in Cairo, and these had been agreed to by the Board. He concluded by moving the adoption of the report and the payment of a dividend of 6 per cent. on the preferred shares, free of income tax.

Mr. Thomas Lloyd seconded the motion, which was adopted.

EASTERN EXTENSION TELEGRAPH COMPANY.

The thirty-ninth ordinary general meeting of this Company was held at Winchester House on Wednesday, when Sir J. Pender, M.P., occupied the chair.

The **Chairman**, after going through the principal items in the accounts, said the policy of the Board had been clearly appreciated by all. Very few companies who came before their shareholders as they did could show a more satisfactory result in the general working than they had done. They all thought there was a great deal still to be done which required very close attention, and something more than attention—a good deal of knowledge—to work up satisfactorily all those problems which came up between the Australian colonies and the mother country. He knew there had been some talk about the Government purchasing the cables, but that would cost from £35,000,000 to £40,000,000, and where the money was to come from he did not know; but if the purchase did really come off, the shareholders would participate in the benefit accruing. He moved the adoption of the report.

The **Marquis of Tweeddale** seconded the motion, which was passed.

PHONOPORE COMPANY.

The fourth annual general meeting of the shareholders of the Phonopore Company, Limited, was held on Wednesday at Winchester House, Old Broad-street. the Right Hon. Sir Mountstuart E. Grant-Duff, G.C.S.I. (the chairman), presiding.

The Secretary (Mr. Charles Isaac) having read the notice convening the meeting,

The **Chairman**, in moving the adoption of the report, referred to the present condition of the Company, and stated that there would be a call of 2s. 6d. upon the preference shares shortly. He pointed out that the work hitherto had almost wholly been of a preliminary character, and that since Mr. Spagnoletti joined them the instrument has been perfected so as to be used over much longer distances. It was working with success from London to Bristol on the Great Western Railway, and from Bristol to Plymouth, and over such distances as from Derby to London. They trusted to be able to push the invention in all directions, and the Directors would be disappointed if a year hence he could not give them more cheering accounts of their prospects.

Mr. E. F. Webster seconded the motion.

Mr. Langdon Davies moved as an amendment: "That the meeting be adjourned until this day three weeks, to enable the Board to confer with a group of shareholders on the position of the Company, and report the result.

The amendment was seconded by **Mr. Fellows**.

Mr. Pollard strongly deprecated the appointment of a committee at the present juncture, because he considered that it would injure the Company.

Upon a show of hands the amendment was rejected, and the report agreed to by a large majority.

The retiring directors were then re-elected and a vote of thanks given to the chairman and Board.

COMPANIES' REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Sir John Pender, G.C.M.G., M.P. (chairman); J. Denison Pender, Esq. (deputy chairman); Sir George Elliot, Bart; Admiral of the Fleet Lord John Hay, G.C.B.; Admiral Sir George H. Richards, K.C.B., F.R.S.; Sir James Anderson; Sir Eyre Massey Shaw, K.C.B.; J. C. Parkinson, Esq.; John B. Verity, Esq. Secretary, E. Cunliffe-Owen, Esq., C.M.G. Chief engineer, Frank Bailey, Esq., A.M.I.C.E. Consulting engineers: The Lord Kelvin, D.C.L., Pres.R.S.; Dr. John Hopkinson, F.R.S.

Report of Directors and abstract of accounts to be presented to the shareholders at the sixth ordinary general meeting of the Company, to be held at Winchester House on Friday, April 21, at 12 noon.

The capital expenditure, which at the end of 1891 amounted to £486,926, now stands at £550,859. 16s. 11d. This increase is chiefly due to the laying of additional mains, and the works in connection with the new station at Paddington, which, it will be remembered, was not contemplated in the original estimates. For the purpose of completing the Company's present system it will be necessary to issue the balance (£50,000) of the £100,000 debentures already authorised. The gross revenue for the year amounted to £54,571. 19s. as against £43,747. 1s. 3d. in 1891, or an increase of £10,824. 17s. 9d. It will, however, be remembered that the revenue of that year included a special item of £3,027. 1s. 3d. paid by the contractors. The actual increase therefore amounts to £13,851. 19s. The balance to the credit of the revenue account. before providing for depreciation, is £18,168. 1s. 1d. The Directors have set aside £4,000 as a depreciation fund, carrying to the credit of the net revenue account the sum of £14,168. 1s. 1d., which, with the balance brought forward from the last account, and other receipts, makes a total of £15,144. 11s. 3d. After deducting bank charges, debenture interest, etc., there remains a balance of £12,558. 18s. 1d, of which the Directors have appropriated £1.000 in reduction of the preliminary expenses account, which will now stand at £4,052. 10s. 4d. The Directors recommend that a dividend of 4s. per share be now paid, which will absorb a sum of £9,980, carrying forward the balance of £1,578. 18s. 1d. to the next account. A comparison of the present revenue account with that for 1891 will show that the Directors' anticipations as to the increase in percentage of net profit are being fulfilled, and they look forward with confidence to a continuous increase in the proportion of net profit to gross revenue in the future. The number of 8-c.p. lamps supplied by the Company, which at the end of 1891 was 82,000, increased during the year 1892 to 124,000. The number at the present date amounts to 134,453. It will be noticed that the rate of increase is constant, and the applications continue to show steady progress. The generating station at Paddington is completed, and in regular and satisfactory operation. A report from the Company's chief engineer is appended, with reference to the condition of the stations, machinery, and plant. The Directors have appointed Sir Eyre Massey Shaw, K.C.B., to a seat on the Board. In accordance with the articles of association, the following directors—viz., Sir John Pender, G.C.M.G., M.P., Sir James Anderson, and Sir George Elliot, Bart.—retire from the Board, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., retire, and offer themselves for re-election.

CAPITAL ACCOUNT YEAR ENDING DEC. 31, 1892.

Dr.	Expenditure to Dec. 31, 1891. £ s. d.	Expended during the year. £ s. d.	Total expenditure to Dec. 31, 1892. £ s. d.
Lands including law charges, incidental to acquisition	12,388 18 9	—	12,388 18 9
Buildings	125,010 0 11	8,419 12 7	127,439 13 6
Machinery	149,460 3 6	4,895 16 5	154,355 19 11
Accumulators at generating and distributing stations	6,175 8 11	567 3 8	6,742 12 7
Mains, including cost of laying the mains	106,193 7 2	23,346 11 9	129,539 18 11
Transformers, motors, etc.	36,231 12 10	12,589 3 3	48,820 16 1
Meters, and fees for certifying under the Act	5,398 19 11	2,556 6 11	7,955 6 10
Electrical instruments, etc.	974 14 9	361 11 2	1,336 5 11
Station fittings (cable, mains, lamps in stations)	1,485 19 8	527 5 0	2,013 4 8
Purchase of patents or patent rights	—	—	—
Parliamentary expenses, cost of licenses, provisional orders, etc.	7,358 9 2	261 19 0	7,620 8 2
Expenditure on offices, including furniture at offices, stations, etc.	2,354 10 2	185 7 4	2,539 17 6
Proportion of management and general expenditure, chargeable to capital—viz., engineer's department, including consulting engineers, maps, plans, etc.	10,721 1 7	1,764 10 5	12,485 12 0
Law, auditors', and accountants' charges	1,091 11 5	358 14 6	1,450 5 11
Rents, rate and taxes, salaries, Directors' fees, and other expenses ...	22,081 8 1	4,787 10 1	26,868 18 2
Special items: Expenses relating to compensation for damage, and cost of properties acquired	—	3,311 18 0	3,311 18 0
	486,926 6 10	63,933 10 1	550,859 16 11

Cr.	Receipts to Dec. 31, 1891. £ s. d.	Received during the year. £ s. d.	Total receipts to Dec. 31, 1892. £ s. d.
Ordinary shares of £10 each	496,486 9 0	2,255 0 0	498,741 9 0
Founders' shares of £10 each	1,000 0 0	—	1,000 0 0
Debentures at 5 per cent.	—	50,000 0 0	50,000 0 0
	497,486 9 0	52,255 0 0	549,741 9 0
By balance			1,118 7 11
			£550,859 16 11

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1892.	£ s. d.
Capital account—amount received	549,741 9 0
Temporary loans	6,000 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	23,129 15 4
Sundry creditors on open accounts	1,545 15 6
Depreciation fund	4,000 0 0
Net revenue account—balance at credit thereof ...	11,558 18 1
	£595,975 17 11

Cr.		£ s. d.
Capital account—amount expended for works		550,859 16 11
Stores on hand—Coal	470 0 0	
Oils, waste, etc.	421 6 2	
General	5,479 3 7	
		6,370 9 9
Sundry debtors for amounts paid on account of contracts in course of completion		2,189 17 1
Preliminary expenses	5 052 10 4	
Less charged to net revenue account	1,000 0 0	
		4,052 10 4
Sundry debtors for current supplied		23,706 1 11
Other debtors...		636 13 9
Deposits (provisional orders, vestries, etc.)		5,812 10 6
Cash at bankers:		
Messrs. Prescott, Dimsdale, and Co.	914 11 3	
The Royal Bank of Scotland	1,350 6 11	
		2,264 18 2
Cash in hand		82 19 6
		£595,975 17 11

REVENUE ACCOUNT FOR THE YEAR ENDING DEC. 31, 1892.

Dr. A.—To Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	15,277	18	6			
Oil, waste, water, and engine-room stores	2,165	12	9			
Proportion of salaries of engineers, superintendents, and officers	1,508	13	4			
Wages and allowances at generating stations	5,114	13	4			
Repairs and maintenance as follows: Building, £208. 12s. 11d.; engines, boilers, £2,495. 17s. 11d.; dynamos and exciters, transformers, motors, etc., £78. 16s. 6d.; other machinery, instruments, and tools, £602. 17s. 5d.; accumulators and accessories, £94. 11s. 10d.	3,480	16	7			
				27,577	14	6
B.—To Distribution of Electricity.						
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	45	19	8			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	230	8	10			
Pole rents and wayleaves	16	6	9			
				292	15	3
C.—To Proportion of Rents, Rates, and Taxes.						
Rents payable Rates and taxes				2,645	5	2
D.—To Proportion of Management Expenses.						
Directors' remuneration	1,238	16	0			
Salaries of management, secretary, engineers, accountants, clerks, and messengers	2,713	6	2			
Wages of meter readers and wiring inspectors	245	11	1			
Commission to canvassers	64	4	2			
Stationery, printing, and agreements	246	10	8			
General establishment charges	815	7	5			
Auditors	146	8	6			
				5,470	4	0
E.—To Proportion of Law and Parliamentary Charges.						
Law expenses				33	8	0
F.—To Special Charges.						
Insurances				384	11	0
G.—To Depreciation Fund.						
Depreciation in buildings, plant, machinery, etc.				4,000	0	0
Total expenditure				40,403	17	11
Balance carried to net revenue				14,168	1	1
				£54,571	19	0

Cr.	£	s.	d.
Sale of current, less reserve for doubtful debts, allowances, etc.	50,852	11	6
Rental of meters and other apparatus on consumers' premises	3,095	1	6
Rents receivable	42	0	0
Transfer fees	46	10	0
Special items: Net proceeds of work done for and goods supplied to sundry consumers	395	11	8
Surplus properties: Rents and profits after deducting cost of repairs, rents, rates, taxes, and expenses of management	140	4	4
	£54,571	19	0

Dr. NET REVENUE ACCOUNT, DEC. 31, 1892.	£	s.	d.
Bank charges and commission	4	14	8
Interest account	283	1	3
Interest due and accrued on debentures	1,458	6	8
Amount written off in respect of work done, not recoverable	839	10	7
Amount written off on account of preliminary expenses	1,000	0	0
Balance applicable to dividend on ordinary stock or shares	11,558	18	1
	£15,144	11	3
Cr.	£	s.	d.
Balance brought from last account	5,454	19	10
Less dividend of 2s. per share paid 14th May, 1892	4,990	0	0
	464	19	10
Balance brought from revenue account	14,168	1	1
Discounts	511	10	4
	£15,144	11	3

St. Helens Technical School.—At St. Helens Town Council recently, a letter was read from Colonel David Gamble, C.B., an alderman of the borough, conveying to the town a plot of 1,500 square yards of land, accompanied by a sum of £20,000 for the erection of a central library and reading-room and a school for technical education and manual instruction. The Council tendered their heartiest thanks to Colonel Gamble for his gracious gift.

BUSINESS NOTES.

Lightning Men.—We notice that Messrs. Newalls, of Leadenhall-street, are requiring lightning-conductor men.

Burton.—Last week a Local Government Board enquiry was held at Burton-on-Trent relative to the borrowing of £11,500 for electric lighting. The proceedings were formal.

Partick.—A Bill has been prepared by Mr. Burt and Mr. Mundella to confirm a provisional order made by the Board of Trade under the Electric Lighting Acts, 1882 to 1890, relating to Partick.

Liege.—The establishment of a central station is offered for tender at Liège. Plans and conditions of contract can be obtained from the Bureau des Travaux Public, Hotel de Ville, Liège. The tenders must be sent in by June 15.

Great Northern Telegraph.—A dividend of 7s. 2d. per share is proposed by the Board for the year 1892, and the transfer of £83,333 to the reserve and renewal fund, carrying forward £45,666 to the credit of the current account.

Yarmouth.—The Yarmouth Town Council have instructed their surveyor to prepare an estimate for the necessary work outside the Town Hall, and resolved to let the work inside stand over until the building had been wired for the electric light.

Nelson.—The Local Government Board have sanctioned the borrowing by the Nelson Corporation of £6,000 more to complete the electric lighting scheme in the borough. It is the balance of £10,000 to be expended in the carrying out of the scheme.

Limehouse.—The services of Prof. Henry Robinson have been engaged for the purpose of reporting fully to the Limehouse District Board of Works on the question of electric lighting for the district and its cost. A special committee has this matter in hand.

City and South London Railway Company.—The receipts for the week ending April 16 were £861, against £734 for the corresponding period of last year, or an increase of £127. The total receipts for 1893 show an increase of £1,222 over those for the corresponding period of 1892.

Bristol.—The Bristol Board of Guardians have been written to by the town clerk, asking if the Guardians were likely to have an installation of the electric light, as the mains of the Corporation would be laid in Peter-street. The matter was referred to the Court of Assistants to report upon.

Blackpool Pier.—Messrs. Challoner and Son have obtained the contract for fitting the Central Pier with the electric light. A large number of arc lamps are to be erected. The bowling-green at the Talbot Hotel will also be lit up with the electric light on special occasions during the season.

Aberdeen.—The subject of the lighting of the new buildings of the Northern Co-operative Company, in Gallowgate, Aberdeen, was taken up at the meeting of directors, and among the proposals submitted was one to the effect that the electric light should be introduced. The matter was left over for further consideration.

Electric Business.—An electric lighting and wiring business, value about £3,000, is offered by an advertiser in the *Daily Chronicle* of Tuesday, together with art-metal factory, as a going concern, for disposal or partnership. An illustrated catalogue, with blocks of designs for many installations already carried out, is thrown in.

Enterprise at Wigton.—During the last week or two the shop of Mr. Hayton, chemist, has been lighted by the electric light, and the High-street is quite illuminated by the lights. The whole of the fittings have been put in under the superintendence of Mr. T. I. Hayton, son of the proprietor of the shop, who made the dynamo himself.

Brighton Scheme.—A letter was read at the Gravesend Town Council meeting last week from the Brighton Corporation inviting this Court to request the borough member to oppose a Bill to promote electric lighting in Brighton in competition with the Corporation. This was referred to the Land and Finance Committee. A similar letter was read at the Southampton Town Council.

Fuel Economisers.—We understand Messrs. E. Green and Son, Limited, of Manchester and Wakefield, have just secured the contracts for fuel economisers to heat the feed-water in coneection with steam-boilers to be erected at the Londonderry and Nottingham electric light installations; also at the installation about to be put down by the Great Northern Railway at Holloway Station.

West India and Panama Telegraph Company.—The receipts for the half-month ended April 15 were £2,789, against £2,656. The December receipts, estimated at £5,219, realised £5,275. The Directors recommend dividends for the six months ended December 31, 1892, of 6s. per share on the first and second preference shares, and 6d. per share on the ordinary shares, placing £1,500 to reserve and carrying forward £1,430.

Chester.—At the Chester Town Council meeting last week, Mr. Tom Browne asked when they might expect a report on the electric light. With the near approach of this new illuminant, he wished to know whether it was necessary to put up further lamps. Alderman Johnson said the introduction of the light was within reasonable distance. Two reports have been received, and the committee will meet very shortly.

Brighton-Rottingdean Electric Railway.—The National Telephone Company, who were the only opponents to the Bill for powers to construct an electric railway along the foreshore from Brighton to Rottingdean, have given notice of the withdrawal of their threatened opposition, the promoters having agreed to insert a clause for the protection of their wires. The withdrawal of this petition leaves entirely unopposed this projected railway, which is to "be placed at such an elevation as to be safe from interruption by the sea."

Prices at Blackpool.—The success of the electric lighting undertaking of the Corporation, says the *Blackpool Gazette*, will depend not upon the half-dozen big companies of the town, but upon the hundreds of small consumers who will want a steady supply the year through, and without whom the venture would be a distinct failure. Why not, therefore, fix the price of the light at the lowest sum possible, and put every consumer upon an equality—a system which has worked admirably in Blackpool in the case of gas?

Prices at Bristol.—The Bristol Electrical Committee have issued a circular to the public in the area proposed to be lighted, inviting applications for private supplies. It is explained that an 8-c.p. electric lamp (equivalent to an ordinary gas-burner) would cost about 6s. 6d. per annum. The cost of wiring and fittings may be taken as varying from 25s. to 35s. per lamp for shops, offices, etc., and from 30s. to 50s. per lamp for private houses. The current may be used for motive power, for cooking, or for heating.

Winchester.—By advertisement the Winchester Town Council invite specifications, plans, and estimates for lighting the streets and public buildings of the city, and also for the lighting of houses and shops. A premium of £30 will be paid for the scheme which in the opinion of the Council is considered the most suitable. No pledge is given to carry out any selected plan. Printed conditions can be obtained upon application to the town clerk. The specifications are to be sent to the town clerk (sealed and marked) not later than the 20th of May next.

Carlisle.—From the minutes of the Gas Committee of the Carlisle Corporation, it appeared that at a meeting of the committee the town clerk had submitted copies of letters which he had received from the Brush Electrical Engineering Company, Limited, on the subject of electric lighting, and that the committee had passed a resolution to the effect that while keeping the matter under careful consideration with a view to taking action when desirable, the committee were of opinion that the time had not arrived for taking steps with respect to electric lighting.

Bolton.—The newly-appointed electrical engineer to the Bolton Corporation (Mr. J. H. Ryder, of Halifax) has now entered upon his duties, having had assigned to him the School Board offices in the Town Hall. The new department is yet in an initial stage, and the engineer is engaged upon plans of the necessary work proposed to be carried out. Many of the tradesmen are anxiously awaiting the laying of the Corporation mains. Some time, however, will necessarily elapse before the scheme is carried into effect, but the Gas Committee are pushing on with the work as quickly as possible.

Jarrow.—A good illustration of the utility of electric light is seen in Jarrow at the new Co-operative Stores, where the whole of that immense building is illuminated throughout by means of the electric light. It has been found a great boon in the shops comprising these stores, but has been seen to most advantage in the large lecture-hall, which is lighted with 34 Edison-Swan lamps, the splendid light from which has been fully appreciated by those attending meetings, concerts, and balls. Only three or four renewals have been necessary since these premises were opened over 12 months ago.

Wakefield.—A sub-committee of the Wakefield Corporation has for some months been seeking information from the towns which have adopted the electric light, and it is expected that a report will be presented before long. The town clerk has not yet received instructions to apply for a provisional order (which will cost about £300), but decisive action is contemplated next week, so that during the summer a scheme may be brought forward, though the order would not come into force till the beginning of 1894. Before anything further is done an experienced electrical engineer will be consulted.

Bombay.—On March 17, the electric-light installation in the new Municipal Buildings at Bombay was tested, and proved an entire success. The Council-chamber, as well as the other parts of the buildings, looked at their best when lighted by the admirably-arranged electric installation, the supervision of which was carried out by Mr. P. Massop, of the Laing, Wharton, and Down Construction Syndicate. There are 366 lights in the buildings, varying from 10 c.p. to 50 c.p. The lights on the central stairs and under the dome are similar to those at the Hooghly Bridge Calcutta. A large horizontal engine drives Thomson and Houston dynamos from the municipal workshops, near the Crawford Markets.

Electric Mining.—At the meeting of the Silati River Gold Mining Company on Tuesday, the Chairman stated that Mr. Pasteur had left for the Cape, and after disposing of some necessary business at Johannesburg, their colleague would at once proceed to the Silati district. He would examine into all the conditions of the problem as to the introduction of electrical power of working by water instead of steam the whole of the machinery at Silati, which was really the object of the increase of the capital. The Chairman felt quite sure that it would be practicable to introduce motive power by working electrical dynamos, and in that case an immense reduction in their working expenses would be made.

York.—At the monthly meeting of the York City Council last week, the Electric Light Committee stated they had received a report from Mr. Bernard Drake, and a report from the borough surveyor as to the route along which he considers it most advisable for the Scarborough Electric Supply Company's mains to be laid, and also as to whether it is most advisable for the mains to be laid in the carriageways or footways of the streets, were laid before the committee. It was resolved that the reports be approved and adopted, with the addition that the mains be laid throughout the route as near to the houses as possible. Mr. Gawne moved, Mr. G. E. Hudson seconded, and the committee's report was adopted.

Middlesbrough.—At the last meeting of the Middlesbrough County Council, on the Gasworks Committee minutes coming up for adoption, the Mayor read a letter enclosing a resolution of a meeting of ratepayers strongly opposing any increase in the price of gas. Alderman Hugh Bell moved, in accordance with notice, that the price be increased by 3d. per 1,000 cubic feet. The gasworks, he said, did not return to the town a sufficient income for the expenditure which had been incurred. At the present moment the works were an extremely hazardous commercial enterprise. In a few years they might find themselves compelled to consider whether they should not abandon their gasworks and take over other means of lighting.

Colombo Tramways.—The Colombo Municipality, upon the casting vote of its chairman, has decided to accept the tender for the construction of tramways in Colombo submitted by Mr. E. D. Mathews, who has recently carried out a similar undertaking in Karachi to the entire satisfaction of that municipality. Mr. Mathews proposes to begin work within six months of execution of the contract, and to carry on the construction of the tramway lines at the rate of six miles per annum, without being bound as to the order of any particular route. He agrees to pay half of all net profits over 7 per cent. to the Council. There was some proposal some time back to use electric traction, but no mention is made of this in the notice above.

Edinburgh.—The Lord Provost's Committee of the Edinburgh Town Council, on the 12th inst., approved of a sub-committee's report recommending that the Corporation should themselves undertake the carrying out of the powers conferred upon them under their electric lighting order. The following was the division: For the motion: The Lord Provost, Bailies Steel, Dunlop, Gulland, and Macpherson; treasurer M'Crae, Convener Ramage, Councillors Pollard, Mitchell Thomson, Kinloch Anderson, Sloan, and Mackenzie. For the amendment (to transfer the powers to a company on conditions to be afterwards arranged): Bailie Walcot, Dean of Guild Miller, Councillors Colston and Williams. Bailie M'Donald and Councillor James Robertson declined to vote.

Telegraph Construction and Maintenance Company.—In reply to a shareholder the secretary states: "The fall in the price of the shares is no doubt due to the reduced dividend, and that is occasioned by the small amount of work carried out by the Company during 1892, which was considerably less than in previous years. The severe depreciation which has very generally prevailed has affected us, in common with nearly all manufacturing and industrial concerns. We hope shortly to sign a contract with the Eastern and South African Telegraph Company for the manufacture and laying of a cable between Zanzibar and Mauritius, but while the present slackness of trade continues it is impossible to say what are our prospects of work as regards the general business of the Company."

Indo-European Telegraph.—The Company's revenue from all sources for 1892 amounted to £117,479. 13s. 10d., as compared with £116,699. 3s. 1d. for 1891, showing an increase of £780. 10s. 9d. Deducting the expenses, taking credit for £5,983. 15s. 4d. brought over from 1891, and debiting income tax, there remains the sum of £60,057. 16s. 11d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £39,432. 16s. 11d. The Directors now propose the declaration of a dividend for the six months ended December 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., carrying forward £7,557. 16s. 11d. to the credit of 1893.

Crieff.—Provost Adie has been making enquiry recently as to the introduction of the electric light into Crieff. No town in Scotland is said to be better situated for the purpose. An electrical engineer from Manchester recently visited Crieff and examined the water power in the vicinity. It is said he has now furnished a report of his investigations. He estimates that for an outlay of about £3,000 an installation of about 600 lamps of 16 c.p. can be secured, and if accumulators are used an additional outlay of about £2,000 will be required, but in that case the plant would be capable of supplying 2,000 lamps of 16 c.p. It is reported that a splendid waterfall ample for all purposes may be placed at the disposal of the town if the scheme is entertained. At present there is much favourable discussion in connection with the subject and the Provost's efforts to effect such an improvement.

Extensions.—We learn that Mr. Percy W. O. Hodges, A.M.I.C.E., has joined the firm of Messrs. Hodges and Todd, electrical engineers and measuring-instrument manufacturers. This firm, we are pleased to note, is now adding civil and mechanical engineering departments to their rapidly increasing business, and they now undertake to advise and report upon any engineering projects as well as make surveys and superintend the construction of works. In addition to their Turnmill-street works, Messrs. Hodges and Todd have taken large and extensive premises in Red Lion-street, where central-station switchboards, large switches, etc., will in future in made. The offices will still be at 82, Turnmill-street. As there is rather a dearth in London of firms making switchboards, owing to recent failures and retirements, there should be a good chance for this pushing young firm.

Indian Telegraph Extension.—The Indian Telegraph Department is pushing forward with considerable energy the opening up of new offices. By April 1, says the *Indian Engineer*, 100 new departmental and combined offices will have been opened in India since the commencement of the year. A large proportion are in Lower Bengal and Madras, in both of which provinces the telegraphs pay better than in others, a result due not only to the fact that trade is brisker than elsewhere, but also that the people are, on the whole, better educated and seem to understand more readily the great advantages afforded by the telegraph wire. Satisfactory as the yearly reports of the Department have been in the past, still better results may be looked for in the future. Burma should soon commence to assist in swelling the annual returns, and the Kashmir line, which has already been partially taken over, may also prove a paying concern.

Bradford Extensions.—A special meeting of the Gas and Electricity Supply Committee of the Bradford Town Council was held on the 14th inst. to consider the advisability of extending the electricity works in readiness for next winter. Alderman F. Priestman, who presided, said that the principal problem which presented itself was whether it would be best to extend the plant on the two-wire system or to begin afresh with the three-wire system. It appeared from a report prepared by Mr. S. W. Baynes, the electrical engineer to the Corporation, that to double the present two-wire mains would cost £9,630, and that the cost of the three-wire system would be £5,970. There would also be a saving in working expenses on the latter system of £424. Numerous applications for light had had to be put off, and to meet the demand for next winter he estimated that from 200 to 300 additional generating horse-power would be required at the works. A sub-committee was appointed to go into the whole question and report to a subsequent meeting.

Taunton.—At the monthly meeting of the Taunton Town Council last week the Electric Lighting Committee reported as follows: "Your committee report that the Board of Trade have approved of the area of supply adopted at the Council meeting of the 14th February last, and have inserted it in a schedule to the draft provisional order. The committee herewith present the draft provisional order, which is unopposed and will be embodied by the Board of Trade in a Bill which will pass through Parliament. A communication has been received from the Local Government Board enclosing a notice that a public enquiry will be held on Wednesday, 19th inst., by Mr. Codrington, at 10 o'clock, to enquire into the application by the Council to borrow £16,000 for purposes of electric lighting. The committee ask for authority to instruct counsel to appear on behalf of the Town Council at the forthcoming enquiry if they shall deem it necessary to do so." On the motion of Alderman Van Trump, seconded by Councillor Westlake, the report was adopted.

Walsall Electric Trams.—Councillor Baker, at the last meeting of the Walsall Town Council, said that he wished to move that the town clerk write to the tramway company and ask them to reduce the discomforts of the trams. He alluded to two things—the odd arrangement of the seats and the jolting. On the top of the cars, he said, it was positively dangerous to ride, and everyone had to hold on when the car was in motion. The Council had assisted the company in every way they could, and now he thought the public had a right to be treated with consideration. It was positively annoying to the passengers. The Town Clerk said that Mr. Baker could not move a resolution without notice; but he would communicate with the company, and have a reply to lay before the General Purposes Committee. He believed that the arrangement of the seats was already being considered by the company. As to the jolting, that he understood arose from the position of the motors, though perhaps the springs might be somewhat light. However, he would bring both matters before the attention of the company, and had no doubt he would have a report for the next committee meeting.

Metropolitan Electric Supply Company, Limited.—The report of this Company for the year ended December 31 states that the capital expenditure, which at the end of 1891 amounted to £486,926, now stands at £550,859. This increase is chiefly due to the laying of additional mains, and to the works in connection with the new station at Paddington, which, it will be remembered, was not contemplated in the original estimates. For the purpose of completing the Company's present system it will be necessary to issue the balance (£50,000) of the £100,000 debentures already authorised. The gross revenue for the year amounted to £54,571, as against £43,747. It will, however, be remembered that the revenue of 1891 included a special item of £3,027 paid by the contractors. The actual increase, therefore, amounts to £13,851. The balance to the credit of the revenue account, before providing for depreciation, is £18,168. The Directors have set aside £4,000 as a depreciation fund, carry £14,168 to net revenue, which, with the balance brought forward and other receipts, makes a total of £15,144. After deducting bank charges, debenture interest, etc., there remains a balance of £12,558, of which the Directors have appropriated £1,000 in reduction of the preliminary expenses account, which will now stand at £4,052. The Directors recommend a dividend of 4s. per share, carrying forward £1,578.

Kingston.—Mr. Arnold Taylor, C.E., held an enquiry at Kingston last week, on behalf of the Local Government Board, into an application by the Town Council for permission to borrow £16,000 for the purpose of electric lighting in the borough. The Town Clerk stated that the sum required was made up of £11,850, the amount of the tender of Messrs. Siemens, which covered everything, except the erection of the central station. The balance of £4,150 was intended to cover the cost of the buildings and other capital expenditure, if any. Provision was made for 5,000 incandescent lamps and 35 arc lights. The population of the borough at the last census was 27,057; and the ratable value £125,601. The total of the present outstanding loans was £58,575; and there was £5,000 borrowed on the security of certain property. Mr. Preece, jun., gave evidence as to the system adopted and the machinery to be used; and he said it was estimated that if the 5,000 lamps were fixed, they would be able to show a profit of £100 on the first year's working. That was all that could be done with the present plant; but as occasion required the supply could be increased by adding to the generating machinery—the mains being capable of distributing more than double the supply now arranged for. Mr. Clarke, a member of the Council, opposed the application, and he pointed out that at Northampton, although the light had been established there four years, they had only 4,000 lamps fixed, and at Oxford the Corporation could not be induced to adopt the light, because it was unreliable. After some conversation with respect to the amount of the rates in the borough, the enquiry terminated.

Electric Lighting Company Finance.—Under this heading the *Daily News* says: "Very steady progress is being made by electric supply companies towards profits and dividends. At the meeting of the City of London Electric Company some striking diagrams were given illustrating the tendency of receipts to increase greatly, while expenses remain about the same. In our report of the meeting, reference was made to the probability of the company reducing the price of the current to the consuming public. A correspondent points out that the City of London Company has powers to pay 10 per cent. on the whole of its working capital, before it is compelled to reduce the selling price per unit The share capital is at present £400,000, and it will issue as much again in preference capital, some of it bearing 6 per cent. and some of it perhaps less. It is moreover empowered to issue £400,000 of debentures, which will hardly bear much more than 4 per cent. interest. As the 10 per cent. arrangement covers the whole capital, the ordinary may be receiving about 20 per cent. dividend before the obligation to reduce the selling price of the electric current comes into force. At present, the price per unit is 8d., and it appears as if the company will be able to reduce it greatly, still leaving a profit. The Metropolitan Electric Supply Company has issued its report, announcing a dividend of 4s. a share, compared with 2s. per share a year ago, the directors stating they look forward with confidence to a continuous increase in the proportion of net profits to revenue. In this case the scope of high dividends is hedged by founders' shares, which will take half the profits after 7 per cent. has been distributed on the ordinary."

Southampton Free Library.—The Sub-Committee of the Southampton Free Library Committee at the last meeting reported that they had received tenders for the provision and erection of electric-light fittings and plant as follows:

Messrs. J. Sugden and Co., London	£357	0	0
B. Verity and Sons, London	331	4	0
Planet Electrical Engineering Company, London	329	10	0
Fowler, Lancaster, and Co., Birmingham	297	0	0
Siemens Bros. and Co., London	288	0	0
Paterson and Cooper, London	285	0	0
Brush Electrical Engineering Company, London	278	18	3
Emanuel and Son, London	247	0	0
Latimer Clark, Muirhead, and Co., London	241	0	0
Crompton and Co., London	239	0	0
Howard and Co.	239	10	0
Barnett and Co., Newcastle-on-Tyne	226	2	0
Fiford and Sons, Southampton	225	13	0
Sanby and Co., Southampton	220	0	0
Sharp and Kent, London	220	0	0
Noble and Co., Southampton	210	0	0
F. Shalders, Southampton	209	0	0
F. M. Newton, Taunton	171	5	0
Donnison and Parmiter, Manchester	167	0	0

After careful consideration by the committee and by the electrical engineer (Mr. J. G. W. Aldridge), they unanimously recommended the acceptance of Messrs. Donnison and Parmiter's tender to carry out the work for the sum of £167. The proposition was agreed to.

Bristol.—The Electrical Committee of the Bristol Town Council in their report remind the Council that, by their report presented on the 10th of March, 1891, they informed the Council that the sum of £66,000 would be required to carry out the installation which the Council, on the recommendation of the committee, resolved to establish. The committee have obtained the sanction of the Local Government Board to the borrowing on mortgage of the general district rate of the above-named sum, to be repaid in 25 years, and, having received tenders for the loan, they have accepted, subject to the approval of the Council, the tenders of the Corporation of Leeds, to lend the sum of £50,000, and of the trustees of the Bristol General Hospital, to lend the sum of £16,000 at interest at the rate of 3½ per cent. per annum. The committee recommend the Council to execute mortgages of the general district rate to the Corporation of Leeds and to the trustees of the Bristol General Hospital accordingly. They also remind the Council that in Mr. Preece's report, submitted by the committee to the Council on the 10th of March, 1891, and upon which the committee based their estimate of £66,000, it is stated as follows: "In my estimate I have not allowed anything for the purchase and preparation of the site, but I have put down £5,000 for buildings and alterations." In consequence of the nature of the soil forming the site of the central electric lighting station, the committee found it necessary to incur a heavy expense in piling and in building a retaining wall against the river, and they also found it expedient to erect a larger and, consequently, a more costly building than was at first contemplated. Contracts for the whole works have now been entered into, and the committee find that it will be necessary to provide the sum of £17,000 in addition to the before-mentioned sum of £66,000. The committee therefore recommend that they be authorised to make the necessary arrangements for borrowing the sum of £17,000 on mortgage of the general district rate.

Underground Telephone Wires.—At the Manchester City Council meeting last Friday Mr Southern enquired if the committee had had any applications for permission to lay telephone wires beneath the streets of the city, and whether, before permission was granted, they would give the Council an opportunity of fully considering the subject? Sir John Harwood desired to emphasise the necessity of careful consideration being given to the question of laying telephone wires underground. He said that it was the more important in view of the fact that the Salford Corporation, being anxious to lay telephone wires along their streets, found their progress in this matter considerably interfered with by a private company who had previously obtained a privilege objecting to the Corporation doing as they desired except under certain conditions. The Paving Committee must be careful in this matter, and if the chairman of that committee had given any permission, he (Sir John) could only say that the chairman had no right to give that permission. He wanted to know how they stood in this matter, and he would suggest the committee should take the Council into its confidence before allowing these wires to be laid beneath the streets of the city. Mr. Richards said he knew nothing of any power having been given to any telephone company to construct wires through the city. They had always refused to take any responsibility with regard to overhead wires. (It was explained these were underground wires). Alderman King said he had noticed telephone wires being laid under one of the principal streets where the Corporation intended to place wires. It had occurred to him that there might be some difficulty in connection with this matter in the future. Alderman Hinchliffe (deputy chairman), in the absence of the chairman, said, as to the telephone wires, the committee had been applied to by more than one company for permission to lay wires underground, but owing to the illness of the chairman nothing had been done. They had not undertaken any liabilities, nor would they until they had reported fully upon the matter to the Council. The proceedings were approved.

City Lighting.—Colonel Haywood, M.I.C.E., engineer and surveyor to the Commissioners of Sewers of the City of London, has presented his report on the work of the past year. With regard to electric lighting, he reports that on January 1 of the present year there were 409 lamps in operation, comprising 194 in the east, 119 in the central, and 96 in the west district. The length of main thoroughfares lighted on that date was as follows: East district, 5¼ miles; central district, 2¾ miles; west district, 3 miles; total, 11 miles. At the end of last year there were mains and conduits in 22⅛ miles of street: the total length of the trenches opened up to then within the City being about 52¾ miles. The gas lighting in the main thoroughfares was discontinued from time to time as the electric lamps were put into operation. The gas lamps and fittings, however, were not removed; arrangements having been made with the gas company for cleaning and maintaining the lamps ready for lighting to meet the contingency of failure in the electric light. The number of gas lamps unlit at the end of the year was 1,126; the number of arc lamps lighted being 409. Consequently 2·75 gas lamps were extinguished for each arc lamp. The number of public ways remaining in which the electric lighting company have not laid conductors is 621; but the largest portion of these are small streets and courts and alleys and narrow thoroughfares. The company having been required by Colonel Haywood to place experimentally incandescent lamps within the gas lamps in such manner as to leave the gas available for the contingency of failure, the gas company objected to this being done, and expressed their intention of removing the gas fittings when the incandescent lamps were placed inside the lanterns. The question arose as to the propriety of lighting the minor streets by incandescent lamps, and as to the relative cost of gas and electricity for that purpose. The matter was referred to the engineer, who reported thereon to the Streets Committee of the Commission at the beginning of the year; and at the date of the report under notice (March 21) it was still under their consideration.

Llangollen.—At the Llangollen Local Board meeting on the 6th inst., Mr. J. P. Davies brought forward his motion in favour of introducing electric light into the town. He said he had been in consultation with several electrical engineers, and they all spoke favourably of the facilities Llangollen possessed for an effective supply. He need hardly dwell upon the advantage of electric light as compared to gas, and their gas friends need not feel any alarm at the introduction of the former, inasmuch as it had been proved that in eight of the principal towns in England where electric light had been introduced the consumption had not sensibly diminished. Mr. Paull, of Liverpool, suggested that the machinery might be put on a site near Messrs. Griffiths and Son's skinyard. Mr. Davies then quoted statistics showing that the whole plant could be supplied for £1,600, the annual cost of production, including interest on capital being estimated at £136. 10s. As motive power would not be required in the daytime, it might be utilised in working a tram to the top of the Castle or to Glyn. Mr. Sillery, electrical engineer, had estimated that the light could be supplied in Llangollen at half the price of gas. Mr. Hett, from Yorkshire, suggested Pentrefelin Slate Wharf and a site near Llangollen Flour Mill. There was no doubt, however, that the best of all was the canal, as the supply would not be subject to the interference of floods, which was often the case in regard to the river. He (Mr. Davies) understood that two applications had already been made to the canal company for power to put up machinery near the aqueduct of sufficient power to supply Cefn, Ruabon, Rhos, and surrounding district, and that Mr. Jebb, the engineer of the company, was inclined to take a favourable view of the application. He regretted that, as he had not as yet received a report from one of the engineers whom he had consulted, he was not in a position to make any definite proposal on this subject. Mr. Davies then moved that the Local Board take steps to obtain plans and estimates for lighting the town of Llangollen with electricity. Mr. H. O. Thomas seconded. Mr. J. E. Jones proposed the matter be deferred for a month. Mr. Thomas asked whether Mr. Hall was willing to take it up as a speculation. Mr. Davies replied that this gentleman at present had as much on his hands as he could manage. After some discussion it was resolved to defer the matter for a month.

Ipswich.—At the meeting of the Ipswich Paving and Lighting Committee last Friday, it was stated that Mr. Pratt had had printed a statement of his views as to electric lighting, and a copy had been sent to each member of the committee. The question of electric lighting had been referred to the Street and Lamp Sub-Committee, and Mr. Josselyn asked whether the printed statement was the report of that sub-committee. The Chairman replied that it was not. Mr. Pratt was good enough to make a statement to the sub-committee, who thought it well that the information should be afforded to all the members of the committee, but they had made no report. The statement should be discussed by the sub-committee and then come before the committee at large. The Town Clerk said the sub-committee should hear all the observations which might be made, and make their report; but if they were to have the remarks of individual members printed and sent round, the functions of the sub-committee would be trenched upon. Mr. Brand said the sub-committee had thought it would be well to have the remarks in print. Mr. Pratt said there were 63 occupiers between the Barrack-corner and the White Horse and 10 in the Butter Market who were desirous of having the electric light, and he felt that the question of the Corporation obtaining a provisional order ought to be pressed to the front. He did not want it to be shelved, and meant to have it thoroughly thrashed out by the committee. The Vice-Chairman said there was no desire to shelve the question, but he questioned whether the gentlemen who were so anxious to have the light thoroughly understood what difficulties and expenses stood in the way of the Corporation. The object in printing this statement was to afford information. The matter would come before the sub-committee, who would report. The Town Clerk questioned whether the gentlemen who had stated their willingness to have the electric light fully understood what they would have to pay for the fittings, and was told it was extremely unlikely they would go to the outlay which would be involved, for in many cases they were tenants of their premises, and that only for short terms. Mr. Brand said in November next the cost of electric-light fittings would be reduced 25 or 30 per cent., as many of the patents would then expire. He agreed that a great many who said they would like it did not mean they would take it if it were double the price of gas. It was understood that the sub-committee would report, and Mr. Brand and Mr. Turner were added to the sub-committee for this purpose.

Bowness.—At the Bowness Local Board, Mr. Fowkes, representing the electric lighting company, regretted that they had found that the expense of introducing the electric light would be more than originally contemplated. They had found that to light the 72 lamps in Bowness would require 4½ miles of cable, and also that the present lamp heads and posts would not be suitable. When making the original estimate it was upon the strength that the existing lamps could be utilised, but that not being so added materially to the cost, which it had been thought would be £1 per lamp, half of which cost the Board were to pay. However, instead of his company paying one-half the cost of the lamps they were willing to go further, and would pay two-thirds, which would leave 35s. per lamp for the Board to pay. There was another thing he might suggest which would considerably reduce the total cost—that was by concentrating the area to be lighted by the electric light and cutting off some of the outlying lamps, which could still be supplied with gas. In answer to Mr. Baddeley, the Clerk said the gas averaged £80 a year for the 72 lamps. The Chairman remarked that as he understood Mr. Fowkes, an arrangement had been made with the Windermere Board to light their district upon similar conditions to Bowness upon their paying 35s. each towards the cost of the lamps, and now after confessing the obligation he was under to the Bowness Board for the support and assistance they had rendered him, he did not offer them any concession, but put them upon the same footing as Windermere, who had opposed him as far as possible. That was scarcely reasonable. Mr. Fowkes replied it should be considered that he could afford to light Windermere at one-third of the cost required at Bowness. Mr. Baddeley said he could not see what any arrangement which had been made with Windermere had to do with Bowness. They were given to understand the electric light would be provided at the same price as gas, and now it was going to cost 25 per cent. more. The Clerk pointed out that the lamps, which were at first supposed to cost £1, were now found to cost £3. 10s. Mr. Fowkes said £4. 10s. would represent the actual cost, as the present lamps could not be made available. The Chairman thought Mr. Fowkes might meet them by accepting £1. 10s., and he would propose the Board make that offer. Mr. Johnson seconded and it was agreed to. Mr. Fowkes expressed his willinness to leave the matter in their hands, though it would entai dead loss of 5s. per lamp to the company which he knew of, and he was not accepting the terms as a matter of business. Mr. Brown proposed, and Mr. Westlake seconded, that the clerk be instructed to give the required formal notice to R. H. Fell and Sons to supply the street lamps with the electric light forthwith, which was carried unanimously. Mr. Fowkes undertook to get on with the work at once, and to have the lamps from Brookside to the steamer pier lit by the 20th of May at latest.

Blackpool.—At the meeting of the Blackpool Town Council last week, the Electric Lighting Committee presented the following minutes : "The committee have again considered the charges for incandescent and arc lighting. Resolved that the committee adhere to the original scale of charges for incandescent lighting and for single alternating-current arc lamps. That the charge for current for two or more arc lamps be 2d. per lamp per hour up to 1,000 hours per annum, and 2d. less 10 per cent per lamp per hour over 1,000 hours per annum. That the electrical engineer be instructed to enquire from the Fylde Waterworks Company the cost of water required for this committee's department." Councillor Jas. Pearson, in moving the adoption of the minutes of the Electric Lighting and Tramways Committee, said the committee went thoroughly into the scale of charges. They got replies from other places, and they were forced to conclude their former recommendations to the Council could not be improved upon. The first year would be experimental, and their calculations might not come out as perfect as they expected. They were not so far forward that they were able to fix a date upon which to lay the foundation-stone, and he invited the presence of the members thereto next Saturday week. This was seconded by Councillor Hodgson. Councillor Bibby asked the chairman of the Electric Lighting Committee to give a full and clear explanation why the light had not been carried through Claremont Park. Councillor Sergenson supported the minutes, and said an unlimited supply of water would save close upon £400 a year. The statement was made upon the authority of the engineer who was carrying out the work for them. Councillor Fish thought some explanation was required why there should be so much difference as 25 per cent. between one consumer and another. Alderman Bickerstaffe pointed out a committee meeting was held for the purpose of discussing these matters, and the matter was thrashed out. Particulars were given then, and arguments were advanced, and even those who came prepared to vote against went away perfectly satisfied. They must have the large companies in connection with the electric lighting system. Alderman Buckley said they had the power to charge 8d., but had decided to charge 6d. He objected, however, to class legislation. The light ought to be placed in the hands of every private consumer on the same basis as it was offered to a large consumer. He maintained that small consumers would be the great benefactors to this company, and not the large consumers who turned the light on for a few hours only. They required all the energy to supply that current for a few hours. He deprecated such a difference of charge as 25 per cent , and said if it ought to be so it would hold good equally on the gas question. Councillor Hampson said that it was perhaps unfortunate that the chairman of the Electric Lighting Committee was connected with one of the largest companies in the town. The question had been asked why should the Winter Gardens – and he only took that company invidiously because it had been mentioned—have larger discounts extended to them than a smaller consumer. There was a very good reason for this. If they were going to charge the Winter Gardens as much per unit as they would charge the small consumers, then, as business men, the directors of the Winter Gardens would immediately decide to put in their own installation, for they could thus produce the light cheaper. Alderman Bickerstaffe remarked it would be the same with the Blackpool Tower Company. Mr. Councillor Fish said that the defenders of this discount were all connected with public companies. The electric light was for the benefit of all alike, and all should have it at the same price. He entered his protest against any such percentages. Mr. Councillor Heap did not see that there was any difficulty in discerning why these reductions should not be made to large consumers. They required to look at it from plain business and practical principles. They knew very well that the Winter Gardens Company, the Tower Company, or anybody else who consumed a great amount of electricity could produce it at 4d. or 4½d. per unit. Suppose, therefore, the Corporation said : "You must pay the same as the private consumer." They dare not say they could produce the light at 4½d. per unit and pay interest on sinking fund, because the experience of other corporations told them that it was not possible. If they fixed the price at 6d., then the large public companies would not take it, but would instead put down their own plant. If they were content with the small consumers only, as a business undertaking it would soon prove a desperate failure. If they supplied the light to the large consumers at 4½d. per unit, the Corporation would be yet making something out of it. Mr. Councillor Pearson said that the large public companies would be the backbone of their electric-light works. Without these large consumers he was convinced that the works would show a very serious loss during the first few months of their experience, and if they took away the backbone of the concern they could not hope to supply electricity at anything like 6d. per unit, or even 1s. per unit. It must be patent to every property-owner, tradesman, lodging-house keeper, that Blackpool that day stood as the most progressive and most popular of English watering-places, because of the public companies and the benefits they had given the town. Undoubtedly their very first consideration was their ocean, but what formed a very good second ? The public companies of Blackpool, *who had* made it the very popular and very prosperous resort they *found it to-day. Why this* acrimonious objection to this percentage ? It was not because some of them were interested in some of the public companies that they recommended this. He knew that the company with which he had the honour to be connected were advised that they could produce electricity a little cheaper than the Corporation now proposed to supply it at. The speaker proceeded to review at length a number of electric light companies who sought to attract large consumers by offering similar reductions such as the Blackpool committee offered. He contended that the reduction would benefit both large and small consumers ; otherwise they could not supply it so cheaply. He did not hesitate to say that with access to such large consumers as they would have in Blackpool some companies would willingly grant a rebate of something nearer 40 per cent. Passing on to answer Mr. Councillor Bibby's question, the speaker said that the reason why the committee recommended the Council not to proceed with the mains in Claremont Park was simply because they had not before them anything as regarded the scheme for the improvement of the North-end. They did not know what it would eventually be ; whether there would be one, two, or three promenades in Claremont Park, and it would be therefore a sheer waste of money to lay cables and fix lamps at the present juncture. The minutes were then adopted.

Southport.—At the meeting of the Southport Town Council last week, Alderman Hacking moved the confirmation of the minutes, and referring to the fact that it had been decided to engage an expert, Mr. Manville, in regard to the electric light for a fee of 75 guineas, and out of pocket expenses, said he hoped that he would be able to report to them during the next fortnight, Mr. Manville having promised the committee that he would report upon the matter as soon as possible. Councillor Hodge seconded. Councillor Foggitt said he should like to know whether Mr. Manville's opinion was to be final. They had already sent a great many members of the committee on excursions to Oxford and other places to examine the installations, they had provided them with a consulting engineer, and now they were asked to call in an expert. Councillor Hough observed that if Councillor Hatch had stood up to propose a vote of censure upon this committee he could have understood it. The committee was now starting where a sensible committee would have started at first. They had now called in an expert, and goodness knew what it would cost Prior to calling in the expert they had expended over £1,000 in deputations which had visited other towns to study the systems. The expenses of these deputations had been rushed through prematurely. The last, he believed, had amounted to £111. It occurred to him that that sort of expense should be looked into more carefully. When Mr. Wilkinson was appointed they received the most glowing accounts of his abilities from the chairman of the committee, and his appointment was rushed through. Independent of all the experts, they would have his salary to pay. This was not business. It occurred to him that a lot of the money that had been spent in deputations had gone to make electrical engineers of some of the committee at the ratepayers' expense. Some of them knew more than the engineer. That was where the difficulty came in. He had no doubt that Mr. Wilkinson was the clever young man they represented him to be, but why was all the secresy observed about the undertaking ? They could get to know nothing. They were now asked to wait another fortnight. If there was another deputation he should certainly oppose it, and he hoped they would have something tangible to bring before the committee without throwing away much more money of the ratepayers. Councillor Boocock thought the deputations should be complimented rather than blamed for the work they had done, and for the time they had given up to the work. He thought the Gas Committee were now going on the right lines in getting a practical man to confirm the opinions they had formed, or their engineer had formed. Certainly the length of time occupied had been very serious, but there had been a very great many enquiries made with the view of finding out the best method of lighting. They were now, at any rate, within measurable distance of the light ; and he would say let them have the most perfect system that could be devised, so that people might be attracted to Southport by the excellence of the installation. Councillor Barlow said that the money had been well spent perhaps everyone would allow, but he did not see why the accounts of the deputations' expenses should be destroyed before there was a chance of inspecting them in any shape or form. He had been told, when asking a question upon this matter, that the accounts were destroyed as soon as the bills were paid. Councillor Griffiths said he believed that a great many members of the Council knew more about electricity now than they did before the question was undertaken. It was the importance of the question and its intricacy that made progress slow ; but he was quite certain that whatever might be the final result, the Corporation in the long run would never regret that the committee into whose hands the charge of the electric lighting fell did most painstakingly go into the whole question with a very honest desire to let Southport have the very best system of lighting it was possible to obtain at the present day. If the deputations had wasted the ratepayers' money they were open to censure. If the work had been judiciously done, he did not think the members of the Council would grumble. He did not see that any good purpose would be served at the present time by raising any question with regard to their engineer. What they wanted now was to get as soon as possible a report of a practical character. The sooner they could get the electric light into the town the better it would be for Southport, and the better satisfied the Council would be. Councillor Threlfall could understand the necessity for cautious procedure on the part of the Gas Committee. If they adopted a scheme hurriedly, it was quite possible they might find themselves committed to the expenditure of many thousands of pounds through inexperience, and they might find they had made a very serious mistake which it would be in many cases impossible to rectify. Councillor Karr asked whether the plans which were passed so many months ago would be reported upon or no? Were the plans for generating stations and the rest to be upset? To his mind the whole matter had been muddled. He moved that the question of the payment of £75 be referred back to committee Councillor Hodge said he believed they had got men at the head of this business who would produce a light second to none up to date. After having visited Oxford, London, and other places where electric lighting was in force, he had learned a great deal about electricity, and was now prepared to vote for it. He did not think the money had been badly spent. Councillor Isherwood thought that if they spent thousands of pounds on enquiries and got the right thing at last, the money would be better spent than if they rushed into the question and had to do it all over again. They must remember that the science was comparatively new, and the changes from one thing to another were extremely rapid. The Deputy Mayor said he was a member of the Gas Committee, but not of the Electric Lighting Committee, and he would like to say that in all his experience of the Council he had never seen a committee which had given so careful and constant attention to anything committed to its care as the members of the Electric Lighting Committee had done, and as there were so many different views on that subject, they must not be surprised if the committee could not see eye-to-eye with one another as to the best thing they could recommend. He wanted to relieve the chairman and the members of the Electric Lighting Committee of any imputation that they were at all diffident in the matter; they had an honest desire to present to the Council, when the time arrived, the best-digested scheme for lighting the borough by electricity that was possible to have. Alderman Hacking thanked the deputy mayor for his remarks, and said that in all his statements as chairman of the committee he had simply endeavoured to represent to the Council the feelings of the majority, and not his own individual opinions. When gentlemen spoke about deputations costing £1,000 they were conveying a very erroneous impression to the ratepayers. Included in that amount were the preliminary expenses involved in getting the order, which must be counted by hundreds of pounds, and they had also paid about £300 to their electrical engineer. Then they must remember that the Council had ratified the large deputations who had gone to different towns. He hoped the committee would not bring a scheme before the Council until satisfied that it was the best possssble scheme. The motion to engage the expert was then agreed to.

Belfast.—A meeting of the Council in committee was held on the 11th inst., the Lord Mayor in the chair, to approve of the recommendation contained in the report of Prof. Kennedy on the electric lighting of the city, and to authorise action to be taken thereon. The report was considered in detail. The portions more closely dealt with were the following: "I have come to the conclusion that you may very probably, within two or three years of starting the works, have to supply current to the equivalent of about 8,500 lamps of 8 c.p. each, wired, in what I have called further on the central district. In the southern district the supplying of one house in every four, which does not seem an over-sanguine estimate, would result in the wiring of the equivalent of about 4,000 lamps of 8 c.p. In the one case it would be amply sufficient to provide for 6,100 lamps alight at the same time, and in the other for about 1,400 such lamps. I have accordingly taken these figures as the basis of my estimates. I estimate, further, that each 8-c.p. lamp in the central district will use about 17·5 units per annum, and in the southern district about 11·5 units. From these figures the income from each district for any number of lamps wired, and for any rate of charge per unit, can be at once calculated. If the numbers of lamps were those given above, and the rate of charge were 6d. per unit, the income per lamp would be 8s. 9d. and 5s. 9d. per annum, and the total income £3,850 and £1,200 respectively in the two districts; but the first amount may very possibly be much larger. The maximum rate at which electrical energy would have to be delivered to consumers would be about 200 kilowatts and 45 kilowatts respectively, these being the figures which govern in connection with each particular system of generating plant the dimensions of the engines and dynamos. The central part of the city is surrounded by a ring—having a breadth of something like three-quarters of a mile, and covering what may be called the industrial as distinguished from the business part of the city—in which there can be extremely little demand for electric light until the work can be carried out on such a large scale as to reduce its price very much below anything at present possible. To do this would require the bold expenditure of probably 10 times the capital which I have estimated for, so as to put the electric and the gas supplies at once on something approaching equal terms, and I can quite understand that you should not feel yourselves justified at present in embarking on such an enterprise. It may be said at once, however, that no electric light scheme short of a great one such as this will really serve to relieve sensibly the pressure on your existing means of gas supply. Of the sites which I have seen for a possible central station two have special advantages. One of these is in Ormeau-avenue, the other is on the river immediately below the Albert Bridge. Both, I understand, belong to the Corporation. The riverside station has the advantage that it would admit of the use of condensing steam-engines. It has the drawbacks, as compared with Ormeau-avenue, that the foundation is very bad, and would have to be piled throughout, and that it is considerably further from the lighting districts. Both sites are of ample area. Either site would serve perfectly for a station generating high-pressure current. The riverside station would be out of the question for a low-pressure system. An ordinary low-pressure three-wire system, indeed, would be considerably more costly than any other, even with a station in Ormeau-avenue, and the excess of cost is greater than I feel justified in recommending you to incur. At the same time, I believe that in such places as Belfast, where the day load is always very small, and where the difference between summer and winter lighting is (on account of their northern latitude) much greater than the average, it is of special importance to be able to economise both labour and fuel at times of low load, and the most practicable method of doing this which appears applicable to your case is the use of batteries. Taking this view of the matter, I have been led to try to scheme out some system by which you could gain the advantage of the use of batteries at a cost very much less than that of a direct three-wire system worked from one central station in the usual way. This could no doubt be done by means of sub-stations containing continuous-current transformers on the Oxford system. When, however, I worked out the details of this scheme, especially with reference to the existence of satisfactory reserve plant at the sub-stations, so that you may be practically certain that no ordinary machine failures can endanger the lighting, even over a limited area, its expenses appeared to be as great in your case as that of an ordinary direct-current system. In my opinion, after the most complete consideration which I have been able to give to the whole case, the most economical and advantageous form of sub-station for you to adopt is one in which the dynamo or dynamos are driven by ordinary gas-engines using town gas, which costs, I understand, a minimum price of about 2s. 3d. per 1,000 cubic feet in Belfast. I recommend, however, that this central sub-station should be used in a very different fashion from an ordinary sub-station. It should be really in every respect the headquarters of the system of distribution. It would contain probably two gas-engines, each of about 50 i.h.p., with corresponding dynamos, and would contain also a battery of moderate output—say about 500 ampere-hour capacity. It would contain all the principal regulating apparatus and instruments, and would be always at work when it was necessary for any machines to be running at all. It would be connected with the central station simply by a pair of trunk mains. It would not, however, contain any special reserve plant—that is, any plant kept systematically idle as stand-by—because in case of failure of any machine the additional current could always be sent through the trunk mains from the central station without any disturbances of pressure in the distribution. The central station, on the other hand, would not be always at work, although the use of of gas-engines would allow its machinery to be started at any moment if required. Even in the winter it would only be necessary to have it open for one watch per day. It would contain the plant for taking up three-fourths of the load, together with all reserves, plant which would occupy more space than could be found conveniently in the centre of the city. But an examination of the load curves from existing lighting stations shows that this output would only be required for a few hours, and always (in places not subject to sudden fogs) at times well known beforehand. Further than this, I find that in London the maximum load in an electric-light station in summer is about one-third as great as in winter. In Glasgow the proportion is about the same in the case of gas. From figures kindly furnished me by Mr. Stelfox, I see that in Belfast the maximum demand for gas is only about one-ninth as great in summer as in winter. If the demand for electric light should vary in anything like the same proportion, there would be three or four months in the year during which it would not be necessary to run the central station at all. The small sub-station would be sufficient to generate all the current required. Such a system of working as I have proposed would necessitate the use of gas-engines in the central as well as in the sub-station, for it would be obviously impossible to have a steam-worked station always ready to take up load, and yet only actually working for a very few hours daily, and sometimes not at all, without a most proportionate waste both in fuel and in labour. The cost of coal per unit under such conditions would be much more than the cost of gas. But even although, taken all round, the cost of gas may probably be greater than the cost of coal would be from one station, although it must be remembered that coal is somewhat dear with you, I think this will be fully balanced by the reduced expenditure in wages and by the much greater facilities which will exist for dividing the work between the stations. A basement area having an area of about 750 or 800 square feet (or less if direct-driving engines could be obtained), situated somewhere towards the centre of the city, would entirely serve the purposes of the sub-station. The southern district, for the number of lamps which I have estimated, would be served by about 100 i.h.p. altogether, of which one-half might be placed in 25-h.p. units in (probably) two sub-stations and the rest in the central station. The sub-stations would be connected with the central station, as already described, in such a way that the latter might serve as reserve in all emergencies, and also might supply half the required power at the heaviest loads. The distributing mains would be connected through to the central district, so that the batteries might keep the mains alive always, and supply the very small amount of current which only would be required for 18 hours out of the 24 for the greater part of the year. I estimate the total cost of the scheme which I have recommended, exclusive of land, buildings, and meters, but inclusive of the whole of the plant and machinery, mains, and roadwork, at about £19,000 for the central district. This is for plant which would, as I have already stated, suffice to keep 6,100 lamps of 80 c.p. each (32 watts) alight simultaneously, with sufficient reserve, and which would therefore allow at least 8,500 lamps (probably a larger number), to be actually connected to the mains. I think your actual station expenses, including salaries, wages, gas, stores, and repairs, when you have 8,000 lamps wired, should be about 3d. per unit sold. Expenses of management, rent, rates and taxes, interest and sinking fund, and a necessary and proper allowance for depreciation, will add 3d. per unit more to the cost. It would seem, therefore, not unreasonable that you should start the electric supply with a charge of 7d. per unit. But as so large a proportion of the total cost is practically fixed charges—salaries, wages (within limits), rates and rent, interest, and depreciation – the very best way to reduce the cost per unit is to increase the number of units sold. From this point of view you will no doubt consider very seriously whether it would not be the wiser policy to start with a charge of 6d. per unit at once in order to raise the output as speedily as possible. The cost of supplying current in the outlying districts is naturally considerably greater than in the central district. I estimate the necessary capital expenditure on the southern district (including about 10,200 yards of roadwork, nearly double the amount in the central district) at about £11,000. This covers, as before, all plant and machinery, mains, and roadwork, but not buildings, lands, or meters. This sum is, as will be noticed, about twice as great in proportion to the probable income to be derived from it as in the case of the central district. By the use of an alternating-current system, with high-pressure distribution and isolated transformers in customers' premises, the cost could be reduced by about £1,500. Of course, such a difference in cost cannot be overlooked, but I believe the increased cost of production would, as I have already said, very much more than balance this." On the motion of Councillor Young, seconded by Councillor M'Cammond, J.P., it was resolved that so much of the report as the Gas Committee approved of be now adopted, and that the further steps be taken with regard to the erection of the central station.

PROVISIONAL PATENTS, 1893.

April 10.

7297. **Improvements in and connected with secondary batteries applicable also to primary electric batteries.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

7342. **An improved system of conductors for the distribution of electrical energy and in apparatus used therefor.** Arthur Bergtheil and Robert Alfred Marples, 1, Queen Victoria-street, London.

April 11.

7358. **The gipsy telephone or electric mahatma.** Joseph Wood, 53, Forshaw-street, Barrow-in-Furness.

7387. **Improvements in or relating to machines for electrically welding metals.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.)

7389. **Improvements in apparatus for electrically welding or working metals.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin United States.)

7404. **Improvements in globes, shades, saucers, glasses, incandescent lamps, lanterns, and other appliances used for diffusing and increasing the light arising from electricity, gas, candles, mineral, and other oils.** James Long, 92, Tooley-street, London Bridge, London.

7407. **Improvements in electric meters.** John William Jones, 13, Dornton-road, Balham, London.

7423. **Improved means for telegraphing.** William Henry Fahrney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification)

7424. **Improvements in electric arc lamps.** Addison Goodyear Waterhouse and the Waterhouse Electrical Manufacturing Company, Limited, 45, Southampton-buildings, Chancery-lane, London.

7437. **An improved microphone.** Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Charles Mildé, Son, and Co., France.) (Complete specification.)

April 12

7470. **Improvements relating to electric railways, tramways, and the like.** Percy Willis, 55, Chancery-lane, London. (James B. Sheldon, George L. Van Beek, and Daniel J. Murnane, United States.)

7471. **Improvements in and connected with electric annunciators.** Edmund Raynsford Wilder, 70, Market-street, Manchester. (Complete specification.)

7488. **Improvements in electric battery apparatus.** Jacob Ayton Archer, 55, Chancery-lane, London.

7491. **Improvements in or relating to incandescent electric lamps.** Thomas Oddy, 9, Warwick-court, Gray's-inn, London.

7509. **Improvements in incandescent electric lamps.** James Cooper, 21, Finsbury-pavement, London.

April 13.

7559. **Combined switch and lampholder.** William Harding Scott, Gothic Works, King-street, Norwich.

7575. **Improved electrical apparatus for heating water or other liquids automatically at any desired time.** *Charles Henry Prichard, 9,* Warwick-court, Gray's-inn, *London.*

7561. **Improvements in electric railway signalling.** Illius Augustus Timmis, 2, Great George-street, Westminster, London.

7581. **Improvements in electric arc lamps.** Alfred David Lewis and Frank Michael Lewis, Bream's-buildings, Chancery-lane, London.

7594. **Improvements in the electrolytical decomposition of chlorides and mixtures thereof and in apparatus for the purpose.** Farnham Maxwell Lyte, 53, Chancery-lane, London.

April 14.

7600. **Improvements in electrical heating apparatus.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

7623. **Improvements in methods of and apparatus for the conversion of the energy of electricity into that of light** Reginald Wood, 17, Gower-street, London.

7645. **Apparatus for showing the phenomena resulting from the application of heat to crystals and other substances, and for slides generally requiring heat for use with microscopes and polariscopes, the heat being generated by means of electric energy.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

7647. **Improvements in rapid telegraphic transmission.** Charles Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

April 15

7687. **A new or improved conductor for electric and telephone wires.** Nathaniel Daniel Isaac Oman Gold, 115, St. Vincent-street, Glasgow.

7697. **Improvements in dynamo-electric and electro-dynamic machines.** Horace Robinson, 78, Great Bridgewater-street, Manchester.

7702. **Improvements in electric signalling apparatus and systems for railways.** James Yate Johnson, 115, St. Vincent-street, Glasgow. (Jacob William Lattig and William Frederick Detwiller Pascoe, United States.) (Complete specification.)

7703. **Improvements in electric signalling apparatus and systems for railways.** James Yate Johnson, 115, St. Vincent-street, Glasgow. (Jacob William Lattig and William Frederick Detwiller Pascoe, United States.) (Complete specification.)

7711. **Improvements in electrical accumulators or secondary batteries.** Paul Schoop, 28, Southampton-buildings, Chancery-lane, London.

7713. **Improved gland joint for electrical conductors.** Walter Claude Johnson, 28, Southampton-buildings, Chancery-lane, London.

7714. **An improvement in electric targets.** Arthur James Hervey Wyatt, 28, Southampton-buildings, Chancery-lane, London.

7722. **Improvements in fabric for medical electric appliances, or the like.** John Harrington Haywood, 323, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1892.

5931. **Dynamo-electric machines.** Spence.
7569. **Electric lamp switches.** Everitt.
8258. **Electric collectors.** Smith and Wilson.
8663. **Electromagnets for motors, etc.** Joel.
8956. **Electro-medical belts, etc.** Knox.
9132. **Heating and welding by electricity.** Howard.
9147. **Electric fittings.** Ebbutt and Verity.
11526. **Electric cables.** Hardingham. (Felten and Guilleaume.)

1893.

2361. **Depolarising galvanic elements.** Szymanski.
3572. **Printing telegraph receiving instruments** Wright.
3747. **Electrolytic copper.** Lloyd.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	6¼ 4½
London Electric Supply	5	1½
Metropolitan Electric Supply	—	7¼
National Telephone	5	5⅞
St. James'	—	8¼
Swan United	3½	3¼
Westminster Electric	—	5¼

NOTES.

Polytechnic.—A position of some utility and influence is open as the principal of the Borough-road Polytechnic.

Indian Technical School.—The Governor-General of Bengal has sanctioned the opening of a technical school at Burdwan.

Stafford.—The engineering and electricity classes of the Stafford Town Council, according to the report of the Technical Education Committee, have been very successful.

Society of Arts.—A paper will be given on Wednesday, May 3rd, before the Society of Arts, by Prof. S. P. Thompson, F.R.S., on "Practical Electrical Problems at Chicago."

King's College.—The thirty-third annual dinner of King's College old students will take place at the Holborn Restaurant on Monday, May 15th, with Mr. W. H. Preece, F.R.S., who is a Fellow of King's College, in the chair.

Furstenfeld.—We have received from Herr Oscar V. Miller a most interesting illustrated account of the electric distribution at Fürstenfeld-Bruck, using the water power of the Amper. Alternating currents are used, the transformers and switches being placed in little huts at the side of the road.

Worcester.—On the recommendation of the Watch and Lighting Committee, the Worcester Town Council have resolved to apply to the Local Government Board for the loan of an additional sum, not exceeding £9,000, for the electric light generating station at Powick. It was stated that the total cost of carrying out the scheme would be about £40,000.

Dahl Single-Phase Motor.—We are not yet able to give the details of the Dahl single-phase alternate-current motor, of which mention was made recently, on account of patent rights. The machines, however, work satisfactorily, and considerable business is expected in this class of motor. The Dahl machine, by the way, has three field coils, and six poles instead of three, as mentioned in our previous note.

The Wave Theory.—It is greatly to be desired, says a review of Oliver Heaviside's "Electrical Papers" in the *Electrical World*, that the author will supplement this great work by a systematic treatise, bringing this method of treatment and theories within the grasp of the vast majority who are unable to follow them connectedly in their present form. It is none too soon to introduce the ideas of wave propagation that are displacing older theories in the upper circles of science.

Country Roads and Electricity.—The *Scientific American* (April 15) contains a long article stating the views of the Wheelmen's League, who wish to introduce a Bill to the effect that at the cost of 10,000,000dol. electricity should be laid on "all country roads" in New York State, and thus through a general distribution of electrical power to enable farmers to travel where they please and carry on their farm labour by electric power. A truly comprehensive scheme!

Lecture.—An interesting lecture was given at the Croydon Public Hall last week by Mr. Robert Hammond on the subject of "Electric Lighting: Its Present Position and Prospects." The lecture was arranged under the auspices of the Croydon Chamber of Commerce, and the proceeds of the lecture are to be given to the Croydon General Hospital. The Mayor (Councillor Foss) occupied the chair. The hall was tastefully lighted by means of current from a neighbouring installation.

Station-Lighting.—The Gare St. Lazare, at Paris, has now 770 h.p. in all for electric lighting. There are 11 dynamos of 550 ampères and 80 volts, giving a total capacity of 484,000 watts. The arc lamps give a total of 101,750 c.p., and the incandescents 30,000 c.p. The mean illumination by arcs is 1·27 c.p. per square metre, and by incandescent lamps 1·5 c.p. per square metre. The current used in incandescent lamps is measured by 45 Brillié meters.

Concert.—Some idea of the large interests involved in the City lighting might be gathered last Thursday at the Bohemian concert of the City of London Electric Lighting Company, where some hundreds gathered at Café Monico, under the genial management of Mr. David Cook. The Scotch songs were particularly applauded, and the Chinese marches made a great hit. A very pleasant evening was spent by the employés of the company with their wives, sisters, guests, and friends. The Bohemianism came in with smoking after 9 o'clock.

Public Arc Lamps. — It is interesting to note the different ways in which Brockie-Pell arc lamps are now run in practical use for public lighting. With the direct current we have Oxford and Dundee, using two in series on 100-volt continuous-current supply mains; in Dublin 55 and 25 lamps run in series; in St. Pancras they are in multiple series (10 parallel and 10 in series). For the alternating-current circuits, Bray, Ireland, has 24 in series direct from an alternator; and at Newcastle-on-Tyne the lamps are run with a transformer at each lamp.

City Electric Lighting Company.—At the Commissioners of Sewers on Tuesday, the solicitor made a statement with respect to the alteration of the clause which the City of London Electric Lighting Company asked the Court to agree to prior to its going through Parliament. He proposed that the reserve fund of the company should be applicable to everything except the equalisation of dividends. The solicitor also asked for permission to employ junior counsel, the cost, however, to be borne by the company. The Court agreed with the solicitor's recommendations.

Sweden.—The mountains in Sweden, besides iron ore in the interior, are valuable now because of their waterfalls on the surface. A large electrical transmission plant of 400 h.p is nearly finished in which a waterfall at Hüll-See is utilised by means of four turbines. Two turbines drive dynamos for power purposes, one for electric lighting, the fourth being spare. The distance to the first station is 10 kilometres (about six miles), a second is 4 kilometres further, the third is 1½ kilometres still further, and a fourth is a short distance from this. The second and third distribute the most current both for power and for light.

High Efficiency.—The Schuckert Company guaranteed an efficiency for a 400-h.p. dynamo and engine for the Hanover central station of 85 per cent. for the engine, 90 per cent. for the dynamo, or a combined efficiency of 76·5 per cent. In practice a combined efficiency of 81·8 per cent. has been obtained—88 per cent. for the engine and 93 per cent. for the dynamo. These results are even better than those of the 400-h.p. dynamo built by the same firm for the Dusseldorf station, which gave 92·7 per cent. on full load and 91·6 per cent. on two-thirds load. The measurements at Hanover were carried out by Prof. W. Kohlrausch, of Hanover, and those at Dusseldorf by Prof. Kittler.

Photographic Development by Electricity.—Combining two experiments made by Schützerberger in 1869, and Eder in 1886, Herr Liesegang, of Dusseldorf, has succeeded in developing photographic negatives by electricity. He passes the current from six Gassner dry cells through an almost concentrated solution of bisulphate of soda, containing two electrodes of platinum, separated by a porous vessel. If a photographic plate is immersed in the liquid surrounding the negative electrode, the image is developed in a few minutes with a reddish-brown tint. The liquid remains quite clear. No inconvenience is experienced from the decomposition of the liquid, as the separated elements recombine under the influence of the current. In the fixing bath it loses in intensity, but preserves its reddish tint.

Compressed Air v. Electricity. — It may be expected that experiments on a large scale will within a few years be possible on the relative efficiency of power transmission by compressed air and by electricity. A compressed-air system is to be introduced at Niagara Falls power plant in competition with electricity. Prof. Unwin dwelt upon this question in his recent Cantor lectures, giving figures for air-power transmission over long distances. He considers transmission by compressed air is practical to a distance of at least 20 miles. It seems that 10,000 h.p. can be transmitted to a distance of 30 miles in a 30in. main at 132·3lb. per square inch, with a loss of pressure of only 12 per cent. The efficiency of such a plant is said to be 40 or 50 per cent. if the air is used cold, and 59 to 73 per cent. if the air is reheated.

Varley Testimonial Fund.—As the appeal sent out towards the close of last year for a Varley testimonial fund did not meet with the response anticipated by the committee, it has been resolved that the members composing the committee should personally see their friends on the subject. We may remark that any sums that are intended to be given may be sent at once, without waiting for further application, to the hon. secretary, Augustus Stroh, Esq., 98, Haverstock-hill, N.W., who will acknowledge receipt. It is also hoped that steps will be taken to secure Mr. S. A. Varley a Government pension, but the object of the subscription list was to purchase an annuity as a grateful recognition from the industry at large of his immense services as a discoverer and inventor in the field of dynamo-electric machinery.

Alternate-Current Motors.—Mr. E. Arnold has a second article on "The Calculation of Alternate-Current Motors" in *Electrical World*, April 8. A 9-h.p. single-phase motor, he states, has just been erected by the Oerlikon Company to start the 100-h.p. synchronous motor in the mill of Lendi and Parli. The first single-phase motor put into actual operation was a 2-h.p. motor started in December last year at Chur (or Coire), Switzerland, used to drive the printing machinery of the daily newspaper, the *Neuen Buendner Zeitung*. These motors have, like the multiphase motors, neither collector brushes nor contact rings, and their efficiency is near equal to that of the multiphase-current motors. They are made in standard sizes for 110 volts of ⅛, ¼, ¾, 1½, 2, 3, 4, 6, and 9 horse-power. The excellent results given will lead to their wide adoption.

Leicester.—At the Leicester Town Council meeting on Tuesday, the scheme of electric lighting for the borough was discussed. The principle had already been agreed to, but there was at a former meeting a difference of opinion as to which of two schemes was preferable. They had since been submitted to Prof. Kennedy, who recommended the scheme of the Brush Company. Alderman Lennard, chairman of the Gas Committee, said that the borough would not be called upon to pay anything extra to the rates. They expected to lose about £1,000 the first year, and £500 the second year. In the third year they hoped the light would pay, in the fourth year they expected to wipe off the £500 deficit of the second year, and in the fifth to get back the £1,000 originally sunk. After that they thought they might contribute something to the exchequer. They had already a number of applications for it, and only that day they had an application for 500 lights. Another firm wanted 600 lights. It was unanimously agreed to sign a contract with the Brush Company.

Insects and Searchlights.—Mr. L. Newitt, electrical engineer at the Elswick Works, in reference to electrical searchlights, said in a recent lecture that it might be interesting to hear what happened during the late war around the coast of Egypt. To test the power of the beam, the British Consul at Port Said one night sat in the garden of his hotel and read the *Times* with the greatest of ease by the light of a projector whose beam had been thrown a distance of 4½ miles from one of the battleships. Some of the ships had instructions to follow the movements of the enemy by the aid of the searchlight, which in every case was more than two miles from the shore. However, in spite of this great distance, it was found that millions of winged insects were attracted by this beam of light, and travelled along the beam until they struck the glass in front of the projector and fell into the well around the searchlight, where they accumulated into a seething mass 2ft. deep. They had to be cleared out by the free use of a hose-pipe, but these insects were such a pest that it became difficult to find a man who would stand by the projector to keep it working, owing to the attacks made upon him.

"Campania."—The new Cunarder "Campania" is now the largest steam vessel afloat for active service. This vessel, 620ft. long, is only 80ft. shorter than the "Great Eastern," but is built on far finer lines, and her advent in the Mersey has attracted great attention. The captain on the bridge, 60ft. high, looks quite a diminutive atomy to be directing such a moving mass. The breadth of the vessel is 65ft. 3in., depth to upper deck, 43ft., while the tonnage is 12,950 gross. The portholes in the upper tier number no less than 115 on each side. The "Campania" is the embodiment of grace, power, and beauty, notwithstanding her enormous size. The engines are triple expansion, the most powerful ever constructed, each set being capable of indicating 14,000 h.p. to 15,000 h.p. The ship is, of course, lighted throughout with electric light, upwards of 40 miles of wire being employed. Everything that human ingenuity could do has been done to render the ship as near perfection as possible, both as regards safety and convenience of passengers. The "Campania" comes just in time for the additional traffic to the Chicago Exhibition. It is stated that £150 was paid for the first booked berth.

Royal Meteorological Society.—At the monthly meeting of this society, held on the 19th inst., a paper was read entitled "Notes on Two Photographs of Lightning taken at Sydney Observatory, December 7, 1892," by Mr. H. C. Russell, F.R.S. These photographs were taken with a half-plate view-lens, mounted in a whole-plate camera, and, as a matter of course, there is some distortion at the edges. Both photographs show the gaslights in the streets as white specks, the specks being circular in the centre and crescent-shaped in other parts of the plate owing to distortion. The lightning flashes are also distorted. Mr. Russell believes that this distortion may account for the so-called "ribbon" flashes which are seen in many photographs of lightning. He has also made some measurements of the length and distance of the flashes, and of the intensity of the light. Another paper, "Notes on Lightning Discharges in the Neighbourhood of Bristol, 1892," was read by Dr. E. H. Cook. The author gives some particulars concerning two trees in Tyntesfield Park which were struck by lightning, one on June 1, and the other on July 18, and also some notes concerning a flagstaff on the summit of Brandon Hill which was struck on October 6.

Incandescent Lamps as Geissler Tubes.—Mr. E. M. La Boiteaux, in the *Scientific American*, says: "The idea of utilising burned-out incandescent lamps for performing Geissler-tube experiments may be new to many. The experiment may be performed as follows: Procure a burned-out lamp, if possible one in which a piece of the filament has been broken off, leaving the ends separated about an inch. Solder a piece of wire to each terminal of the lamp, and connect to the secondary terminals of an induction coil yielding about a ½in. spark. Start the coil in action, and holding the globe in one hand, begin to file off the glass point where the lamp has been sealed. This operation must be performed very cautiously, using a fine file with a gentle pressure. The filing should be continued until the discharge diffuses the bulb, and then the point is quickly sealed in the flame. It is, of course, apparent that the object in filing the point is to allow a certain amount of air to enter the globe, producing a low vacuum, through which the discharge will readily pass. The writer has obtained quite a number of beautiful and varied luminous effects in this manner by using the lamps of different manufacture and with very little trouble."

Killed by Electricity.—A singular electric accident is reported from Berlin. In one of the theatres there a piece is given in which during the first act there is a thunderstorm. In order to produce the lightning two electric cables are used, the ends of which terminate in carbons like those used for electric lamps. When a flash of lightning is to be produced, a man behind the scenes unites the poles of the two cables, which produces an electric spark, and the thing is done. For some time past a workman occupied on the stage had always watched the lightning producer with the greatest attention. The other day during a rehearsal he thought he would like to try his hand at it. He took hold of the cables and produced the flash; but in consequence of some awkward handling on his part, so the account states, he received the current through his body, and fell to the ground completely paralysed. He was taken to the hospital, but all medical skill was in vain, and he died from the effects. It is a little difficult to see how this could occur: the voltage for an arc is not often more than 50 or 60 volts. Without further details we can only suppose he was trying the experiment with the wrong cables; or else that in breaking the current he received an enormous extra shock. The case, if true, is worth investigation.

Technological Examinations.—From a circular issued by Sir Philip Magnus, superintendent of technological examinations of the City and Guilds of London Institute, it appears that the committee of the institute have adopted a scheme of inspection, and are prepared to receive applications from county councils or school committees for the inspection of classes in technical (other than agricultural) subjects, and also for special reports on the results of the examination of the students of separate classes registered under the institute. In accordance with this scheme, the committee propose to appoint two inspectors—the one in connection with the engineering and allied trades, and the other with the manufacture of textile fabrics. They further propose to appoint a third inspector for industries involving applications of chemistry, and possibly others will be appointed as occasion may require. The scheme also provides for the appointment from time to time, according to the applications which the committee may receive, of assistant trade inspectors, experts in different branches of industry, having some experience as teachers or examiners. Members of the electrical trades should take note of this in order to ensure that their ideas may be sufficiently reflected in the examinations and thence to the technical colleges. It is in this way only that they can satisfactorily influence the training given in the direction they desire.

Organ-Playing by Electricity.—On Friday last Mr. C. J. Hall (D.Mus.) gave an organ recital in the Higher Broughton Presbyterian Church, Manchester. A large congregation was present. The chief interest in the event lay in the fact that an electric contrivance, the patent of Mr. Hope-Jones, of Birkenhead, was in use for playing the instrument. The organ, which was recently built by Young and Son, of Manchester, is the only instrument fitted on the electro-pneumatic system in that district. The keys are connected by 230 wires, with the appliance for making the organ pipes speak. The electricity is obtained from dry cells, and the current, at the will of the player, acts upon an arrangement of pneumatic valves, which admit the air requisite for producing the desired notes. One feature of the invention is that the player can manipulate the instrument at a distance from it; at this church the cable of the wires connecting the keyboard and the instrument is 60ft. in length, and the organist can, if he chooses, be separated by that distance from the organ without any loss of control over it. The usual draw knobs are dispensed with, and instead are ivory tablets, centrally pivoted, known as "stop keys"; these are placed immediately over the swell manual. In place of the ordinary combination pedals are small piston knobs. A stop switch is provided for arranging any combination of stops that may be desired. The recital fully demonstrated the practicability of the invention.

Dynamo for Electro-Metallurgy.—An illustration is given in *L'Electricien* for April 15 of a 600-h.p. Oerlikon dynamo used for the electro-metallurgy of aluminium, as installed at Neuhaasen. The works at Neuhausen, which employ the Héroult process, have lately increased their plant. The first installation consisted of two 600-h.p. machines, one of 400 h.p. and four of 150 h.p. Four new dynamos of 600 h.p. each have just been erected, making a total of 4,500 h.p. All these dynamos are driven by turbines utilising the water power of the falls of the Rhine. It is in this installation that dynamos directly mounted to vertical turbines, on the plan arranged for Niagara, have been used for the first time. Each of these dynamos is driven by a 600-h.p. turbine by Escher-Wyss, of Zurich, working at 150 revolutions. The dynamo, giving 7,500 amperes at 55 volts, is mounted on the same axle. The turbine is at the bottom, then an enormous commutator or collector with 120 brushes, and on top the armature and field magnets. The total weight of turbine and dynamo is 12 tons. A special arrangement of the turbine has been adopted, as proposed for Niagara, to take part of the weight when running. The dynamo has no special peculiarities save its great size and large number of brushes. The field magnets number 24, and are excited in shunt. The magnetic proportions are such that the position of the brushes vary very little at different loads. The movement of the brushes is brought about simultaneously by a large screw gearing and wheel. The 120 brushes are connected in parallel, and are all mounted on a circular base, which is under control of the screw gearing. The regulation of the turbine vanes is similarly under control, and one attendant is sufficient for two sets of machines.

Chicago Exhibition.—The *Daily News* has a long and picturesque description, the first of a series, in Thursday's issue, on the World's Fair. "The Electrical Building," says the Special Commissioner," is nearer completion than any, and though it is difficult to choose between so many things that border closely to perfection, I am sure numbers of visitors will put a mark against this in their catalogue. The general design is a longitudinal nave 115ft. wide and 114ft. high—crossed in the middle by a transept of the same width and height—both having clerestory windows under the pitched roof. The great exterior feature is a continuous wall of Corinthian pilasters supporting a full entablature. Each corner is adorned with a spire-crowned pavilion. In front of the south façade is an open portico of the Ionic order. The pediments, friezes, panels, and spandrels by figures in relief, or illuminated records, tell the story in outline of the industry which has grown out of electricity. The entire building is 700ft. long and 345ft. wide. I give these figures and facts that some idea may be formed of at least a dozen buildings in this part of the ground. To the eye they are of solid marble, but the effect is produced by a composition called 'staff,' which can be moulded into beautiful forms or nailed and sawn by the workmen. It is a modern and most useful development of stucco. Many of the buildings glow with rich colour — the electrical, for example, having scagliola pilasters, effects in bronze, and the best hues known to the highest class of modern decoration. 'Staff' is said to be a combination of plaster and hemp, and it is applied with rapidity and almost magical effect. A piece of brickwork in two hours I found had been made a stately column with Corinthian capitals. As a collection of modern representations of the classic forms of architecture, of immense buildings that are beautiful, it will not be easy to belittle this sight on the shores of Michigan."

Impedance.—"The impedance of a circuit," says Mr. Kennelly (in a paper reprinted in the American Institute's *Transactions* for April), "is its apparent resistance, and is expressible in ohms. More strictly, it has been defined as the ratio of the effective E.M.F. between the terminals of a conductor and the effective current strength it carries. With steady continuous currents, the impedance of a conductor is its simple resistance. With periodically fluctuating currents the impedance will in general differ from the resistance, and will be greater or less, but in common practice greater. With such voltages and currents Ohm's law becomes $C = \frac{E}{I}$ where the impedance is represented by I." Mr. Kennelly goes on to consider periodic currents of the simple harmonic type, examining "non-ferric" inductances first. The voltage across a condenser may be greater than the original when the values are chosen so that one or both of the factors, current and capacity-speed reciprocal, are large. In such cases the condenser voltage exceeds the voltage of supply, and what is called the "Ferranti effect" is developed. Mr. Kennelly gives many diagrams and algebraical examples with concrete instances, as, for instance, the Thomson wattmeter, the armature of which has a certain non-ferric inductance, and is connected across the supply mains through a resistance. The equality of the meter's record for both alternating and continuous currents depends upon the equality of current strength through the armature under equal alternating and continuous voltages, and this is again dependent on the impedance of the armature circuit. In a particular instrument of 1,500 watts capacity (50 volts and 30 amperes) the total resistance of this circuit is 455·5 ohms, and its total inductance 25 millihenrys (0·025 henry). This represents at 140 ∿ an inductance speed of 22, and an impedance of 456·0 ohms $= \sqrt{(455{\cdot}5^2 + 22^2)}$, so that the current in the armature will be about one-ninth of 1 per cent. less on a supply pressure of 50 volts alternating harmonically, than on 50 volts continuous. Strictly speaking, he adds, the accuracy of a wattmeter depends not only upon the non-diminution of current strength through fine wire circuit in virtue of inductance, but also upon the lag in phase that is also established. It is generally safe to assume that when the error due to impedance is very small, the error due to lag is also very small. An important application of impedance principles is to conductors for the distribution of alternating currents, which Mr. Kennelly works out with curves. Altogether it is a paper which will repay students and engineers alike to peruse with care.

Willans Memorial.—Those who knew the late Mr. Willans, and have recognised the value of his work, will feel that the memory of one who has done so much for practical science deserves to be kept before them by some fitting means. We have, therefore, the greatest pleasure in calling attention to a circular issued by Prof. Alex B. W. Kennedy stating that it has been considered, after discussion, that the most desirable way of perpetuating the name of one who so greatly distinguished himself, and whose experiments were and are still so useful, would be to establish a memorial fund. From this might be awarded a premium annually or biennially, or at such periods as might be thought fit, for a paper on such a general subject as the utilisation or transformation of energy, treated especially from the point of view of efficiency or economy. It has been further thought that it would be advisable to ask the Councils of the Institutions of Mechanical and Electrical Engineers to become joint trustees for this fund, and to award the premium in alternate years to the best paper bearing upon the subject mentioned which had been presented to them in the interval, the premium not to be awarded in case of no paper of sufficient merit being presented. The proposal is particularly *apropos* just now, when Willans's last paper is being discussed at the Institution of Civil Engineers. It is proposed that the fund necessary for this purpose, to be called the Willans Memorial Fund, should be collected by subscription, the subscriptions (unless anonymous) being limited to sums not exceeding two guineas. The gentlemen whose names are given below have agreed to act as a committee for the purpose of carrying out this scheme: William Anderson, Esq., LL.D., F.R.S., W. H. Allen, Esq., Sir Frederick Bramwell, Bart., F.R.S., Frank Bailey, Esq., Noel Chandler, Esq., Latimer Clark, Esq., F.R.S., R. E. Crompton, Esq., Henry Davey, Esq., Sydney Dobson, Esq., Bryan Donkin, Esq., E. B. Ellington, Esq., Prof. George Forbes, F.R.S., W. T. Goolden, Esq., Druitt Halpin, Esq., John R. Holmes, Esq., John Hopkinson, Esq., D.Sc., F.R.S., Walter Hunter, Esq., S. H. Hunter, Esq., J. B. Hunter, Esq., Gisbert Kapp, Esq., the Right Hon. Lord Kelvin, P.R.S., Prof. Alex. B. W. Kennedy, J. Macfarlane Gray, Esq., J. G. Mair-Rumley, Esq., W. H. Massey, Esq., W. H. Maw, Esq., W. H. Mordey, Esq., J. F. Moulton, Esq., Q.C., F.R.S., Thomas Parker, Esq., The Hon. Charles A. Parsons, J. Penn, Esq., V. Pendred, Esq., Prof. John Perry, F.R.S., W. H. Preece, Esq., F.R.S., J. H. Rosenthal, Esq., A. L. Sabine, Esq., Sidney Sharp, Esq., Alexander Siemens, Esq., Major W. Turtle, R. H. Tweddell, Esq., Prof. W. C. Unwin, F.R.S., Major-General Webber, Sir Richard Webster, Q.C., M.P. Mr. Alexander Siemens, 12, Queen Anne's-gate, has consented to become treasurer to the committee, and to him subscriptions should be addressed.

Automatic Railway Signals.—The railway companies have long cast longing eyes on electrical apparatus to see if they could not obtain a practical automatic block system, by which the trains should clear or block themselves. Several systems have been brought forward, but there have always been serious drawbacks. The first question, for instance, that the railway companies ask is: Does the system require special apparatus on the engine? Special fittings mean not only trouble in themselves, but that several companies could not run over one line without all being so fitted. Again, there are certain requirements that must be fulfilled. Mr. W. Langdon, the telegraph superintendent of the Midland Railway Company, in his work on "Application of Electricity to Railway Working," says, in reference to automatic signalling: "Any automatic system should be based upon the principles which govern the block system: 1. The normal condition of the signals should be 'danger'—*i.e.*, any failure of the apparatus, or interruption of the wires, should result in producing this signal. 2. The agency by which the signal is placed at 'clear' should be, and remain, active during the existence of such signal. 3. The apparatus employed should be perfectly free from atmospheric influences. 4. The apparatus should be simple, strong, and not easily deranged." A model set of automatic electric railway signals which fulfil these conditions are shown at 39, Victoria-street, Westminster, by the Automatic Electric Railway Signal Company, of 11, Rumford-place, Liverpool. Two wires are only used, the current is constantly on, keeping the signals at danger. A system of spring contacts, requiring four tons weight to depress them, operate the signals, and this action is brought about by the train itself setting block behind it and freeing it in front. An ingenious system of relays and contacts, arranged with very strong serviceable contacts, brings this action about electrically. An electrically-driven locomotive, on the model shown, demonstrates the through trip and also the effect of shunting. The system seems practical and very carefully worked out. We understand the leading railway companies are investigating the merits of the system, which has been applied practically on a small scale in the Isle of Wight. The following are some of the advantages claimed by the above company for their system, which is protected by letters patent: The action is entirely automatic; the normal condition of the signals is "danger"; the apparatus is not subject to atmospheric influences; there is no attachment to engine or carriage; trains only operate the signals—the passing of platelayers' trolleys, etc., having no effect on them; great simplicity in construction and detail, there being an entire absence of complicated mechanism or clockwork; any break of line wires, or accident to batteries or instruments, sets the signal at "danger"; all working parts are carefully protected, so that they cannot be tampered with; a bell attachment is provided for use during fogs; low first cost, maintenance also low, and a saving in wages consequent upon a considerably reduced staff; sidings cannot be opened until the main-line signals are at "danger," and *vice versâ*. A train may leave a section and set the signal at "clear." Should it, however, from any cause again return to such section, the signal will again be set at "danger." By suitable arrangement, one section or any number of sections can be blocked as desired. Single lines can be blocked in both directions. Now that new lines are being planned for electric working, we should expect, whatever the reception by ordinary railways, that the system should be introduced for these. For ordinary railways it is claimed as far less expensive than the present cabins, which often cost £300 a year each in maintenance.

Kammer's New Sunbeam Lamp.—An incandescent lamp, under the name of the "New Sunbeam" lamp, the invention of Mr. John von der Kammer, is attracting attention in America. The New York *Electrical Engineer*, describing this lamp, says: The base of the lamp consists of two semi-circular discs, one edge of each of which is turned up, and on this the filament wire is mounted. The copper wires leading to the external circuit connections in the base of the lamp are soldered to the under side of the discs. The gap between the parallel sides of the discs is filled up with the fused glass, and the bottom of the glass globe is fused around the circumference of the discs, thus enclosing them entirely in glass. Mr. von der Kammer's method of securing the metallic plates to the glass portions of the receiver is novel and exceedingly ingenious, and at the same time is said to be thoroughly practical. The difference in expansion between the metal base and the glass globe is of no consequence in a lamp constructed in this manner, for there is sufficient flexibility in the metal to permit it to accommodate itself to the expansion of the glass. The metal base can therefore be made of some of the baser metals, as copper. This lamp, however, not being a vacuum lamp, the character of the gas is such that the base can be most easily made of some metal which will resist the action of such gas, as for example, platinum, though a cheaper metal, prepared in advance to receive the action of the gas, will be employed. The lamp has a comparatively high pressure of gas within it, and a "perfect" gas-tight chamber is not so important. The metal seal at the base obviates the necessity of joining glass to glass in the usual manner and also the use of the internal seal-piece, so that if the lamp is slightly damaged in the process of its manufacture, it may be conveniently repaired and resealed at the lower end. Moreover, the bulb can be used again. Although the gas-filled incandescent lamp has for years been declared impracticable, Mr. von der Kammer, by the employment of various expedients, has produced a lamp which does not appear to show any of the objectionable features of such gas lamps as formerly made. The new lamp, though containing a considerable quantity of gas, is said to be even cooler while burning than the ordinary vacuum lamp. There is no disintegration of the carbon, and no electrical disintegration, even when greatly over-run. For example, when a 100-volt lamp is run at 150 volts for a considerable time, the burner will be found to be of its normal colour throughout and practically unchanged. Moreover, the character of the gas employed is such that whatever injury the burner receives or tends to receive from such over-running, is promptly and completely repaired by the gas itself, so that in most instances when the lamp has thus been over-run, it is found not only that the burner is unchanged in its form and appearance, but that its resistance is actually slightly diminished, so that, for example, a 110-volt lamp burned at 100 volts for a short time will give the full candle-power at 109 volts instead of 110. The gas which is employed is produced, it is understood, from a very rare substance, and one which the inventor and the chemists of the company assert has never before been used in connection with incandescent lamps. The manufacturers of this lamp claim for it great utility for certain uses, on account of the quality above referred to, as, for example, on all such circuits as are supplied with currents of varying pressure. The fluctuation of several per cent. in the current will not vitiate the lamp or increase the resistance of its burner, at least not until such fluctuations have extended over a long period, or, in other words, the practical life of the lamp. Besides the advantages in its service as above suggested, the manufacturers state that there is a great change in the method of manufacture. Gas being constantly present in the lamp, and the means of preserving or repairing the carbon being constantly at hand, the lamp requires no such elaborate process of manufacture as does the vacuum lamp.

PARTICULARS RELATING TO

Parish, borough, or district.	Area in acres. (a) Of parish, borough, or district. (b) Of district supplied.	Population.	Number of inhabited houses.	System of electric lighting in use, when adopted, and if proved satisfactory.	Total cost of installation. (a) Site. (b) Works, machinery and plant. (c) Mains	Area of site of station.	Length of mains included in above cost of installation.	Number of 16-c.p. lamps provided for when station fully loaded, and number now installed (including street-lighting, if any).	Number of houses or supplie
†ACCRINGTON	(a) 3,425	38603	8000	Mr. Shoolbred, of Victoria-street, Westminster, is now preparing plans and specifications for an initial scheme to cost £10,000.		2,000 square yards	—	—	—
†*BRADFORD	(a) 10,776 (b) 25,000 sq. yds.	216361	45887	Low-tension continuous. Station opened in Sept., 1889. Quite satisfactory.	(a) A ground rent of £167. 16s. is paid. (b) £34,183. (c) £6,255.	60ft. × 150ft.	19 miles.	10,000 provided for. About 18,000 installed.	The lighti chiefly for and busines mises. Abo use the li
†*BRIGHTON (Corporation)	(a) 2,620 (b) At present 218½ acres, but the Council are about to extend the area of supply to 622½ acres.	116424	19619	Low tension. Quite satisfactory.	(a) £2,500. (b) £19,400. (c) £13,500.	About 912 sq. yds.	4 miles.	10,000, with a maximum of 5,000 in use at one time. About 5,272 lamps installed.	184
*BRIGHTON (Company)	—	—	—	High-tension alternating transformer system. Adopted 1881. Quite satisfactory.	—	—	15 miles of cable overhead.	8,000 at present supplied.	—
†BURNLEY	The Council have at present tenders for an installation under consideration.								
†BURTON-UPON-TRENT	(a) 4,025	46051	8904	The Corporation have only just obtained the sanction of the Board of Trade to a system, and are applying completed for perhaps 12 months.					
†COVENTRY	The question of electric lighting is under consideration in this city, but nothing has at present been done beyond obtaining estimates and schem								
†DEWSBURY	Supply not yet commenced, but advertisements for tenders for the supply of the necessary plant, etc., are being issued.								
†DOVER	No installation has yet been completed here. The Corporation are still in negotiation with the Brush Company as to an agreement.								
†DUNDEE	(a) 4,099 (b) 102 (compulsory).	156000	—	Low-tension continuous current, but not yet in use.	Approximately about £25,000 in all.	29 poles, 10 yards.	Distribution mains, about 3,515 yards. Feeder mains, 1,150 yards	5,000	None as
EXETER	—	50000	10000	High-tension alternating current with transformers. Quite satisfactory.	(a) £1,000 (including building). (b) £7,000. (c) £4,000 (approximate).	660 square yards.	9 miles.	10,000 provided for. 3,000 installed.	120
†FLEETWOOD	Tenders now under consideration. Great competition for the district from various companies.								
GLASGOW	—	560000	—	Low tension (not yet started).	About £60,000.	980 square yards.	About 7 miles.	12,000	
†HANLEY	(a) 1,768 (b) 35	56000	11000	(System proposed to be used.) High-tension alternating current, with low-tension distributing network from converting stations in the compulsory area.	(Estimated) £21,000	Proposed site, 1 acre.	3,450 high-tension mains. 3,150 low-tension mains.	5,000 16-c.p. lamps, all lighted at same time. 300,000 watts with spare plant for one-third more. 20 2,000-n.c.p. arc lamps for street-lighting.	Contract ma not yet com
HASTINGS	The Corporation have not established electric-light works of their own. The electric lamps on the front-line are lighted by a local company under								
HOVE	The Hove Commissioners have transferred their powers to a company—Hove Electric Lighting Company. Deed of transfer not yet approve								
†HUDDERSFIELD	(a) 11,788	95417	20930	The system is not yet in use, but it will be a high-tension (2,000 volts) alternating-current supply to transformer stations.	When completed will be about £30,000 (site leasehold on ground rent).	4,000 yards.	3,000 yards primary, high tension, 6,000 yards low tension.	Present contract will include machinery to supply 4,000 16-c.p. lamps.	System not operatic
†KINGSTON-UPON-HULL	(a) 7,901 (b) 125, to be extended to 250 acres.	204750	49810	Low tension direct with accumulators.	(a) Rent charge of £100 a year. (b) £14,900 (c) £10,100	4,340 square feet.	4,500 yards.	4,500 lamps burning simultaneously, 8,000 ditto when station fully extended. At present about 1,500 installed	Works star December,
*LEEDS	(a) 21,572 (b) Company's order includes the entire borough of Leeds, The compulsory area is a large and scattered one.	387045	70000	High-tension alternating current adopted May, 1892. Works not yet in operation. Hammond and Co., engineers.	(a) £10,000 (b) £18,500 (c) £5,000 (estimated).	5,250 square yards, including space for extension of station to four times its original capacity.	12,500 yards.	3,750 burning at one time, permitting wiring for 7,500. 3,500 lights applied for.	The number sented by th lights is abc
†LLANELLY	No works constructed yet. The Board are in negotiation for transfer of their powers.								
LONDON	—	—	—	—	—	—	—	—	—
*CITY OF LONDON COMPANY	—	—	—	High-tension alternating transformer system.	Works now being largely extended.	—	—	6,500 in use simultaneously and 440 arc lamps of 2,000 c.p.	—
*HOUSE-TO-HOUSE COMPANY, KENSINGTON	600 acres.	50000	10000	High-tension alternating current transformer system. Station opened Jan., 1889. Thoroughly satisfactory.	(a) Leased. (b) £35,000 (c) £20,000	3,133 square yards.	26 miles of cable, 11 miles of cast-iron pipes, junction and surface boxes.	7,500 provided for burning at one time, 12,000 installed. No street-lighting.	Residences flats ...... Shops ...... Hotels ...... Public buildi
*KENSINGTON AND KNIGHTSBRIDGE COMPANY	Limited area around Kensington Court, Cromwell-road, Queen's Gate, and neighbourhood.	—	—	Low-tension continuous current (three-wire) system with batteries.	Expended on capital account at end of 1891, £141,164.	—	—	15,000 burning at one time, about 24,000 now fixed.	—
*LONDON ELECTRIC SUPPLY CORPORATION	Large area in various parts of London.	—	—	High-tension alternating transformer system.	Expended on capital account at end of 1891, £753,428.	3 acres building 196ft. by 210ft. by 100ft	—	50,000 About 25,000 installed.	500
*METROPOLITAN ELECTRIC SUPPLY CORPORATION	Extensive district in West and West Central London.	—	—	High-tension alternating.	Expended on capital account at end of 1891, £486,926.	—	—	—	—
*ST. JAMES'S AND PALL MALL COMPANY	Parish of St. James, Westminster.	—	—	Low-tension continuous current (three-wire).	Expended on capital account at end of 1891, £139,458.	88ft. by 21ft.	—	About 22,500 installed.	—
†*ST. PANCRAS	2,672	234437	24611	Low-tension (three wire).	(a) £10,000 (b) £35,000 (c) £34,894 and £7,682 for public lighting.	—	—	10,000 in use simultaneously. About 11,000 installed. 90 arc lamps of 10 amperes for public lighting.	—
*WESTMINSTER ELECTRIC SUPPLY CORPORATION	(b) 1,6 0 acres	—	—	Three-wire system with dynamos across outer mains with Crompton-Howell batteries.	Three central stations. (a) £17,000 (b) £125,100 (c) £133,000	—	In whole district about 97 miles of copper in 32½ miles of roadway.	75,000. 49,410 installed, as compared with 31,000 on January 1, 1892.	—
†MANCHESTER	The Corporation are now engaged in laying conductors in the streets, but as yet have no machinery or plant at their central station.								
†NELSON (Lancashire)	(a) 3,185	24000	—	Installation not completed.	About £4,000 at present. Electric works at the gasworks.	—	About 2 miles. Service wires, 1 mile.	600	About

ELECTRIC LIGHT INSTALLATIONS.

nber of units l or estimated) elivered to umers during ompleted year.	Price per unit charged to private consumers.	Cost of production per unit, delivered to consumer (including allowance for depreciation, redemption fund, etc.).	Total percentage of costs to revenue.	Is there a good demand for electricity in the district in preference to gas?	AS TO STREET-LIGHTING.				
					System in use for street lighting, and length of streets lighted.	No. of public street lamps supplied, and total estimated c.p. of same.	No. of gas lamps superseded, and total estimated c.p. of same.	Total cost of street-lighting.	Estimated cost during the same period of gas lamps superseded.
—	6d. proposed to be charged.	—	—	Not known yet.	No street-lighting yet provided for.				
1 for half-year ing December 31, 1891.	5d. for lighting purposes, and 4½d. for motive power.	4·04d.	67·33	Yes. Number of lamps fixed Jan. 1, 1891, 8,467 ; ditto, Dec. 31, 1891, 15,000.	No public lighting is done.				
complete year l not expire Dec. 31, 1892.	7d.	Supply commenced in October, 1891, and accounts for first complete year will not be made up until after 31st December.		Yes.	None at present. The Council are about to consider proposals for this purpose.				
—	7d. per unit, with discounts down to 3½d.	—	—	Yes. Extensions in mains being continually made.	No public street-lighting.				
Government Board for sanction to borrow the money so that the works will not be					The Corporation own the gasworks and supply the public lamps.				
ical companies for the lighting, which schemes are now under consideration.									
—	5d. proposed to be charged.	—	—	—	Not as yet known.				
147,000	7½d by meter, and 1s. per c.p. per annum, by contract.	5¾d.	—	Large and increasing demand.	None.				
—	7d.	—	—	—	Brush arc lamps 3 miles.	106 to be supplied of 2,000 nominal c.p. each.	360 pillars. 588 burners.	About £8,000 for plant.	£1334.6s.10d.gas per annum. Maintenance 3s.11d.per lamp. Lighting and cleaning 12s. 5d. per lamp.
h Company, but ations.	Contract for scheme entered into, but the sanction to borrow has not yet been received from the Local Government Board.				(Proposed to be adopted.) Continuous current, lamps in series, 2 miles 640 yards of cables.	20 2,000 n.c.p. lamps, or 30 1,200.	If 30 lamps are installed, 55 gas lamps superseded, having total c.p. of 4,000 candles.	First cost £1,796 included in contract. Estimated annual cost of working, £320.	If 20 lamps as before, £220; if 30, £304.
the Council.									
d of Trade, but there is every reason to suppose it will be.									
—	6d.	—	—	Yes.	Gas.				
7d.	—	—	—	Very likely to be.	Nothing being done in this direction at present.				
—	8d. per unit, less discounts under scale.	—	—	—	No street-lighting.				
—	—	—	—	—	—	—	—	—	—
—	8d.	—	—	Yes.	Arc lamps in about 11 miles of streets.	409, each of 2,000 c.p. nominal (actual power not ascertained)	1,126 of about 14 c.p. each.	£10,634 per annum for 11 miles of main street.	£3,720.
00, being an in- e of 26 per cent over 1891.	8d., less discounts varying from 20 to 25 per cent.	For 1891 about 5½d. with an output of about 260,000 units.	About 79 per cent.	Yes.	None.				
385,050	8d. less discount	5·17d.	—	Yes.	None.				
457,293	7½d.	11·59d.	—	—	No street-lighting.				
1,527,741	7½d.	5·34d.	—	—	No street-lighting.				
—	7d.	—	—	Yes.	No street-lighting.				
—	6d.	—	—	Yes, demand steadily increasing.	Brockie-Pell arc lamps of 1,000 nominal candle-power.	86 86,000 c.p. nominal.	Information not yet obtainable.		
dynamo termi- about 1,500,000.	7d.	—	55 per cent.	Fair.	None at present.				
—	Not agreed upon yet.	—	—	Applications from about 40 intended users of the current.	Street-lighting not gone into yet.				

PARTICULARS RELATING TO

Parish, borough, or district.	Areas in acres. (a) Of parish, borough or district. (b) Of district supplied.	Population.	Number of inhabited houses.	System of electric lighting in use when adopted, and if proved satisfactory.	Total cost of installation. (a) Site. (b) Works, machinery and plant. (c) Mains.	Area of site of station.	Length of mains included in above cost of installation.	Number of 16-c.p. lamps provided for when station fully loaded, and number now installed (including street-lighting, if any).	Number of privat houses or shops supplied.
NORTHAMPTON	—	—	—	Crompton's low-tension system with batteries. Very satisfactory. No case of breakdown since starting two years ago.	(a) £810 (b) £10,000 (c) £7,000	About 8,000 square feet, leaving room for double existing plant.	2 miles.	2,000 lamps on at once. About 2,000 at present are installed.	60
NORWICH	Company not yet commenced the supply. Mains not laid down nor central station completed. Low-tension (three-wire) system adopted.								
†OLDHAM	(a) 4,729	The Corporation have an electric lighting scheme in hand, but, as the work of construction is only just commencing, the queries							
†PAISLEY	Corporation are at present advertising for tenders for transference of the powers under their provisional order.								
PRESTON	—	120000	—	Low-tension three-wire system (110 volts). Adopted 1892. Satisfactory.	—	2,350 yards.	10 miles.	20,000 provided for. 5,000 installed.	150
SOUTHAMPTON	License gives undertakers powers within a radius of five miles. About one mile in length of street supplied.	—	310 on mains	Continuous-current three-wire system with storage. Quite satisfactory.	This cannot be given at the moment. Accounts made up to December 30 in each year.	1,200 square feet, including yard.	1 mile.	1,400 1,200	60
†SOUTHPORT	(a) 7,526	42666	—	Tenders are being invited for a system of lighting.	—	2 acres, 1 rood, 18 perches.	—	2,500 to be provided.	
†TUNBRIDGE WELLS	The Corporation have engaged Mr. W. H. Preece, of the General Post Office, to report to them upon the whole question of the lighting of the borou Mr. Preece is preparing plans, estimates, and specifications. Pending the receipt of Mr. Preece's report, nothing further is being done.								
†WHITEHAVEN	(a) 665	17812	—	The urban authorities have obtained sanction from the Local Government Board [to borrow £14,000 for the purpo					
†WOLVERHAMPTON	No steps have been taken to carry out an installation beyond advertising for tenders.								

NOTE.—Installations marked * have been viewed by the Special Electric Lighting Sub-Committee. In places marked † the local

ISLINGTON.

On March 22 the Special Electric Light Committee of the parish of St. Mary, Islington, signed its report on the electric lighting question to the Vestry. The report is exceptionally good and exhaustive, but neither in our last issue nor in this are we able to deal satisfactorily with it. At the end of the report, a large amount of information is collected in tabular form. This information relates to various light installations spread over the country, and this we are able to give in this and two preceding pages. We are quite sure that the labours of the Islington Special Electric Lighting Committee will be appreciated by all local authorities, and will prove of very general interest. We intend to deal with the body of the report in future issues.

TERMINALS.*

BY J. RENNIE, M.I.E.E.

In the present state of electrical engineering, when currents are being dealt with—not in milliamperes, but in hundreds and thousands of amperes—the portals by which the corresponding energy makes its egress or ingress to any piece of apparatus are certainly worth considering. This will be evident if we think for a moment how the form and character of the valves and passages have influenced the economy of the steam-engine.

Terminals, if they are to be *ideal* terminals, must fulfil these conditions :

(*a*) They must not alter the character or amount of the electrical activity which passes through them.

(*b*) They must be convenient in use, and not liable to become undone through vibration.

(*c*) The contact surfaces must not be liable to become oxidised in places not easy of access for cleaning.

Many other like conditions might be cited, but probably these three may prove sufficient for our present purpose.

Perhaps in what follows I may conveniently confine my remarks to terminals as applied to electrical measuring instruments, not that there is any real limitation in so doing. What I may have to say with regard to them is, I believe, equally applicable to all electrical appliances ; but I hope, by calling your attention to the terminals of instruments, to enlist your attention and bespeak your services in bringing about a reform which is, I think, much needed.

The terminals, as an important part of electrical measuring instruments, have been, I fear, almost totally neglected. Ampere-meters have been growing enormously in capacity, and much ingenuity has been expended in devising instruments for the measurement of large currents, but no part of that ingenuity has been expended on the terminals. In most cases these are merely mammoth specimens of the old P.O. pillar-and-screw terminal. Such a construction of terminal should, I submit, never be seen in a modern ampere-meter, even of the smallest calibre. It is neither scientific nor practical. No amount of pressure, as applied by the screw, can produce more than a fraction of the conductivity that ought to be provided. Even the little that is obtainable is got by deforming one or other of the conductors which it serves to bring into contact. Nor have they the merit of convenience. The electrician would require fingers capable of acting as screw keys, or small vises, to enable him to screw home the terminals of even a 200-ampere ampere-meter.

The familiar pillar-and-screw terminal, neither in its original dimensions, nor when increased in size and capable of taking a cable 1cm. diameter, clamped by a screw of similar size, meets the requirements of (*a*) above. It is possible by hard clamping, preceded by careful cleaning of the surfaces brought into contact, to make a contact of fairly small resistance. But when you consider how likely the end of the cable is to be covered with a semi-insulating covering due to air oxidation, and other contact-destroying matter from the hands, you will readily understand how ill-adapted is this form of terminal to answer the purpose to which it is applied.

In use the clamping screw of such a terminal is apt to become loose, unless it is screwed home with great force ; and even then, in the case of heavy apparatus, such as very large ampere or watt meters, the vibration is apt to loosen them.

Certain variations are to be seen in the pillar-and-screw terminal, some being improvements, others the reverse, all apparently dominated by the idea that only one form of terminal, the pillar-and-screw, is possible.

In one modification common to some electric meters, the aperture into which the end of the cable is inserted is prolonged, and two, or perhaps three, clamping screws applied.

In other forms which are uncommon (perhaps it is patented) the end of the cable is turned to the form of an anchor ring, and is clamped by one screw between two flat surfaces of brass.

A more promising form is one in which the aperture is a hollow cone. The cable is fitted with a conical end-piece, and is drawn into the aperture by a screw nut acting on a screwed prolongation of the conical end-piece.

Again, I have seen an ampere-meter designed to carry up

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* Paper read before the Physical Society of Glasgow University, *March 10*, 1893.

ELECTRIC LIGHT INSTALLATIONS.

Number of units ctual or estimated) delivered to con- imers during last completed year.	Price per unit charged to private consumers.	Cost of production per unit delivered to consumer (including allowance for depreciation, redemption fund, etc.).	Total percentage of costs to revenue.	Is there a good demand for electricity in the district in preference to gas ?	AS TO STREET-LIGHTING.				
					System in use for street-lighting, and length of streets lighted.	No. of public street lamps supplied, and total estimated c.p. of same.	No. of gas lamps superseded, and total estimated c.p. of same.	Total cost of street-lighting.	Estimated cost during same period of gas lamps superseded.
60,000 (estimated).	9d., less 10 per cent. discount for cash within one month.	No reliable data.	No reliable data	Yes, but gas very cheap, and opposition very strong on behalf of Gas Company.	No street-lighting undertaken as yet.				
ot applicable.									
—	7d., less 15 per cent.	—	—	Yes.	500-c.p. arc lamps. 600 yards. 60 yards apart.	1	3	£156 per annum.	
40,000	10d., with a rebate according to amount consumed per lamp fixed.	Works cost 3½d. per unit. (*See* No. 5.)	*See* fifth column.	Yes.	No street-lighting at present.				

y electricity and the best means of carrying out the provisional order. Land has recently been acquired on which an electric lighting station may be erected, and

f electric lighting, and are asking for tenders for the necessary plant.

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authorities are the undertakers, the remaining installations not so marked being carried out by the companies.

to 1,000 amperes having terminals of this very mechanical character. The two ends of its circuit consisted of heavy copper plates, each fitted with loose copper plates and fixed bolts for clamping them together, with an end or a curl of the cable between.

Speaking generally, most forms of terminal may be described as consisting of a hole into which the end of the cable is inserted and clamped.

Now, I do not see that the terminals problem is so very difficult after all ; only let it be recognised as a problem. It is merely to provide an appliance having metallic surfaces which can be brought into such intimate contact that the conducting area between them shall be so much ; the amount depending, of course, upon the current-capacity of the instrument. Hitherto this problem has been but rarely recognised, and designers and manufacturers have been more content to follow ancient practice than to seek an approximation to ideal completeness.

The main thing, of course, is to provide sufficient metallic contact surface. Theoretically, the contact surface for 100 amperes need not exceed 64 square millimetres. But the two surfaces forming the contact must be absolutely clean (copper), and must be in continuous contact throughout the whole area. These two conditions it is practically impossible to attain with the necessary economy of cost, and some other practicable and convenient mode of providing the requisite contact surface must be sought. If we cannot practically get 64 square millimetres of ideal contact surface for our 100-ampere instrument, let us try and get the ideal 64 by providing an actual 640 square millimetres, or 6,400, for that matter, of such a copper surface as we can economically provide and keep. Possibly experiment might point to what the best value for the "factor of economy" should be : whether the surface provided should be 10 times or 100 times the ideal contact surface required.

An admirable solution of the terminal problem has been given by Lord Kelvin, to whom we naturally look for pioneer work. His multiple-plate contact-piece, as applied to all current-measuring instruments now issued under his patents, is the nearest approach to the ideal that has yet been produced. That it is thoroughly effective has been proved by actual experience.

This view of the terminals problem almost necessarily implies the soldering of separate end-pieces to the cables, but I believe there would still be an actual economy in this proceeding. A current of 100 amperes passing through a contact of one-thousandth of an ohm, means an expenditure of from 20s. to 30s. per annum for one instrument alone. The resistance supposed is, I fear, not an unusual one, and when we remember the large number of such instruments and kindred apparatus in use in a central station, we realise the magnitude of the possible loss incurred in merely measuring the electrical energy dealt with. I think there is, therefore, a wide field for effort in minimising such losses as we have been considering.

I have said nothing in the foregoing with respect to the terminals of instruments or apparatus dealing with alternating currents. It is, perhaps, not necessary that special consideration should be given to this feature of the subject. When we remember that there is the surface action in the case of alternate currents, it might appear that the factor of economy should be larger for alternate than for continuous direct currents. With the frequencies most commonly used, however, at the present time, I doubt if the amount of the surface effect is so great as to introduce any modification, and probably there need be no change in the ideal terminal, whether it be designed to transmit alternating or continuous direct currents.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE DISTRIBUTION OF POWER BY ALTERNATE CURRENT MOTORS.

BY ALBION T. SNELL, MEMBER.

(Concluded from page 407.)

(b) Experiments with the Drehstrom Motor.

(1) Star or open-coil coupling. The motor was coupled to a dynamo by belting and then supplied with current at frequencies ranging between 12 and 33·3 ∿ per second. With the lowest frequency the motor ran light at about 700 revolutions per minute, being nearly synchronous with the dynamo. As the load was applied the speed decreased, and since the output was inconveniently small the dynamo speed was raised to about 900 revolutions per minute, when the following readings were taken :

Groups A and B.

No. of test.	Speed of motor.	Pressure on mains.	Amperes in each circuit.	Exciting current in dynamo field circuit.
1	848	58	21	2·5
2	746	55	21	2·8
3	880	77	38	4·5
4	800	77	27	Not taken.
1	888	80	28·7	4·3
2	866	80	27·6	4·3
3	824	75	27·6	4·3
4	890	77	28	3·9
5	790	70	27·6	3·9
6	866	75	27·6	3·9
7	Armature held stationary.	70	34·7	3·9

The frequency was about 15 in the above experiments ; but the dynamo speed varied from 932 to 833 revolutions per minute, owing to the engine governing badly.

The load on the engine was next adjusted so as to give a steady dynamo speed of 960 revolutions, and the tests included in Groups C, D, and E were made.

In C a Prony brake was applied to the pulley of the motor, and in D and E a dynamo was driven, as in the tests of Groups A and B, this being found to be more convenient.

Group C.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.	Weight on end of 24in. brake arm.
1	736	84	31	2lb.
2	624	82	32	3lb.
3	500	83	32·9	4lb.
4	500	81	33	4lb.
5	340	84	34·7	5lb.

The frequency was 16.

Groups D and E.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.	Dynamo speed.
1	0	79	37·8	960
2	340	79	34·8	960
3	512	78	32·5	960
4	740	77·5	30 6	960
5	820	77·5	28·15	960
6	864	76	28·1	960
1	922	91	31	952
2	914	90	32·9	956
3	0	85	39·8	970

In both D and E the frequency was approximately 16.

Next, the dynamo speed was increased to 1,960 revolutions in Group F, and to 2,000 revolutions in Group G; and the motor connections were altered to the triangle or closed type. This required 1·732 times the current and 1/1·732 times the pressure for the same output with the star or open type connections (see latter part of 5). The Prony brake was used in Group F.

Group F.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.	Weight on 24in. brake arm	B.H.P. of motor.
1	1,820	41·5	26·5	1	0·68
2	1,480	41	29·8	3	1·67
3	1,200	40·5	31	4	1·8

The frequency was 32·6.

Group G.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.
1	0	36·5	39·4
2	732	37	35
3	1,000	37·75	35
4	1,276	38·75	30·5
5	1,702	41·5	27
6	1,750	42·5	27 Motor running free.

The frequency was 33·3.

Groups A and B were made to see how far the excitation of the dynamo affected the experiments. The pressure on the mains varies, of course, with the excitation, but the speed of the motor, as far as can be seen from these rough measurements, is nearly independent of the pressure, and seems rather to vary with the frequency and perhaps the lag. The law connecting speed and current variation for constant frequency and pressure of supply is not very obvious, and evidently requires the lag to be taken into account. For example, see Group B: In test 6 the motor loaded with 27·6 amperes in each circuit and 75 volts makes 866 revolutions; and test 7 shows zero speed for 75 volts and 34·7 amperes. Evidently the lag in 7 is far greater than that in 6. This is confirmed by test 1 in Group D, by test 3 in Group E, and test 1 in Group G. It is curious to notice how small are the variations of current between running light and full load, or even when the armature is held stationary. This large waste or idle current is most prejudicial, and if it cannot be lessened by some practical means (by condensers or otherwise) will militate seriously against multiphase motors without commutators. If the revolving part of the motor be supplied with the triphase current, these troubles will be much less; because the moving part will contain less iron, and hence the hysteresis and eddy-current losses, and the induction disturbances will be of less importance. The frequency in the induced circuit is then so small as to give little trouble.

In Group C a Prony brake with a lever 2ft. long was fitted around a 16in. pulley, and the motor was supplied with current of 16 ∿ per second. The pressure and current variations are seen to be insignificant, though the speed varies some 50 per cent. This low frequency (16) was found unsuitable for the design of the motor, since it gave too low a speed; but the tests in Groups D and E were taken so as to shew the capabilities of the motor under these conditions. The power of the motor was utilised to drive a direct-current dynamo, the two machines being coupled by a belt. The figures in Group D again show large variations of speed for nearly constant pressure and small changes of current. In Group E the pressure was increased, but only a few readings were taken, as the increase in speed was insufficient to give results widely different from those obtained in the preceding tests.

In the next experiments the connections of the motor were altered to the triangle or closed arrangement, the end in view being the increase of motor speed and consequent output.

The tests in Group F are some of the most important in the series, for the output measured by the Prony brake was sufficiently large to give practical data. It will be seen that the frequency was 32·6 per second and the pressure about 41 volts. The speed again shows large variations. When running light the speed of synchronism, 1,960 revolutions, was nearly attained.

In Group G the motor was coupled to a small dynamo by a belt, and the frequency was raised to 33·3 per second. In test 6 the motor was running free, but the speed was 250 revolutions below that of synchronism. The best results seem to have been obtained with a frequency of about 32 (test 3, Group F), and it appears probable that if the arrangements had been such as to admit of a larger current at this frequency, at least 3 b.h.p. might have been taken from the motor.

These rough experiments show the importance of reducing the magnetising current to a minimum. It can be accomplished by careful attention to the design and by making the air-gap as small as possible. The Drehstrom motor may be regarded as an open magnetic circuit transformer, and the only way to lessen the waste current is to make the magnetic resistance as low as possible. Mr. C. E. Brown has already suggested bedding the field as well as the armature turns in iron, and the same end may be attained by perhaps a better way—*i.e.*, by winding the field coils in drum fashion.

7. Drehstrom Motors with Stationary Armatures.

Triphase motors are sometimes made with the rotary magnetic field in the revolving part of the machine. This necessitates brushes and rings, it is true, and consequently simplicity of design is departed from, but it must be recollected that there can be no sparking under ordinary conditions. The brushes would probably be made of flexible strands of copper, such as are commonly used for alternators. The chief point gained is that the most marked effects of hysteresis, eddy currents, and self-induction are limited to the relatively small moving part of the machine; whilst the massive stationary portions, which then form the armature, are magnetised by currents of frequency equal only to the difference between the speed of the armature and that of the rotary field. It is clear that the speed of the revolving part can never equal that of the rotary field; but at normal loads the period of the armature current will be small, and therefore the heating from hysteresis, etc., will be comparable with that of a direct-current machine, the period probably being of the order of from eight to ten per second. Herr Dobrowolski's 2-h.p. motor is of this type, and a brief comparison with the small motor built by the author may be interesting, because it will show the order of the results obtained from the two types of machines. Herr Dobrowolski's motor weighed approximately 365lb., and the maximum output deemed advisable was 4 b.h.p, at about 1,700 revolutions per minute. On open circuit it made 2,100 revolutions, and at 2 b.h.p., the rated output, about 1,950. The frequency was 35, the supply pressure 70 volts, and the torque at starting considerable. The lag was stated to be 72deg. when the motor was running light, 28deg. at 2 h.p., and 22deg. at 3 h.p. The efficiency at 1 h.p. was 75 per cent., at 2 h.p., the rated output, it had reached to about 80 per cent., and at 2·3 h.p. it attained its maximum of 81·4 per cent. The author's motor weighed about 300lb., and at 1,200 revolutions gave 1·8 h.p. on the brake, and it was evident from the slight heating that this output could have been safely doubled if the speed had been raised to about 1,800 revolutions, but it had a larger lag than the other machine, the waste currents at small loads were much greater, and the all-round efficiency was certainly less.

8. Combined Rotary and Synchronous Motors.

A multiphase dynamo requires the revolving field magnets to be separately excited by a direct current. It is reversible, and will run as a motor if supplied with a multiphase current, but is not necessarily self-starting, and probably will not start against a large torque. If, however, the magnets be rotated so as to synchronise with the rotary magnetic field, the motor will work as satisfactorily as a single-phase machine.

Attempts have been made to combine the advantages of a self-exciting rotary-field and a synchronous motor. The plan proposed is some modification of the following idea: The moving part, usually the armature, is wound with two circuits, the one closed on itself acting precisely as the closed circuits of the multiphase armature, the second supplied with a direct current and, therefore, having fixed poles. When the field is excited by a rotary current the induced currents in the closed circuits will start the armature (if the torque be not too great), and the permanent poles due to the direct current will have but little influence. But as the speed of synchronism is approached the induced currents in the armature will decrease, and the fixed poles will have more effect, until finally the armature rotation will be entirely due to them.

Such a motor has many disadvantages, besides requiring an independent direct current. It necessarily has a low efficiency at starting and at all speeds below that of synchronism ; but within wide limits of load, when once started, it will run at a constant speed with a high efficiency.

The initial torque cannot be so great as that of a simple diphase or Drehstrom winding, since the closed circuits on which the starting depends are relatively smaller.

Mr. Schuckert has built a self-exciting diphase rotary-field synchronous motor on the above principles. But the method does not appear to offer any special advantages, and it is not likely that such motors will supersede ordinary single-phase alternators.

9. SINGLE-PHASE NON-SYNCHRONOUS MOTORS—SELF-EXCITING AND SELF-STARTING.

Messrs. Hutin and Leblanc, C. E. L. Brown, and others have devised modified forms of Prof. Elihu Thomson's motor, all of which will run with single-phase currents, non-synchronously and with good efficiency.

The principle seems to depend on the induction of currents in short-circuited coils, in unsymmetrical positions with reference to the main field, but this end is not necessarily attained by brushes and rings, as in Thomson's motor, but by the rotation of the armature itself. In its simplest form this type of motor has no commutator, and is self-exciting, but will not start. If, however, the armature be spun in either direction, it will rapidly acquire the speed corresponding to the torque, and will then revolve at a uniform rate.

By the combination of an additional rotary magnetic field, the armature can be made to start against a considerable torque, and the auxiliary field can be stopped after the proper speed is attained. Various devices to secure such a field are suggested by Mr. C. E. L. Brown, the most feasible being two parallel windings on the field magnets, one with small self-induction (or even capacity), and the other with larger self-induction. These two circuits when supplied with a single-phase current will produce a rotary field, and so cause the armature to revolve. (Other forms of this ingenious motor have been suggested by Mr. Brown, for which reference should be made to the technical journals of March of this year.) Most of the arrangements, however, necessitate rings and brushes, and the motor is therefore only preferable to a synchronous reversed dynamo inasmuch as it is self-exciting and self-starting. These two points are of great importance with small motors, and probably the invention will be of utility in many ways.

The general details of construction are, broadly, similar to those of a multiphase motor, but the number of poles in the field magnets and armature must not have a common factor, and the windings of both armature and field magnets are preferably laid in grooves or holes in the iron—an arrangement which permits the magnetic resistance to be reduced to a minimum and decreases losses from Foucault currents, while the weight output is increased. This is perhaps the best type of single-phase motor up to date, but it is undoubtedly susceptible of considerable improvement, and the problem of alternate-current motors suitable for running on ordinary supply circuits cannot yet be said to be satisfactorily solved.

DISCUSSION.

Mr. Kapp opened the discussion at the last meeting. He said electrical engineers in England had been working with a cosine of lag truly shocking. America was far ahead. We had not a single multiphase motor at work. It might be said that alternating-current motors were no use, but abroad they gave excellent results. Three months ago he had received a newspaper from Switzerland printed by a single phase alternating-current motor. Many authors found it convenient to neglect armature reactions for alternate-current motors; this would be like playing Hamlet with the part of Hamlet left out. The three-phase current has the theoretical advantage of being easily regulated, though at first the engineer has great trouble in balancing his circuits. With regard to torque at starting, in alternating motors the torque is very small, due to the fact that the resulting field is wiped out by the armature reaction. One other point he mentioned was that he failed to see why winding the field coils in drum fashion could effect the magnetic resistance. As to terminology, which was armature and which fields, he regarded the "armature" as that which received induced current, and "field" that which receives the original "drehstrom."

The **President**, in adjourning the meeting, said Mr. Sparkes would bring the novel motor of Mr. Brown and explain it at next meeting.

MEETING, APRIL 27.

MR. ALEX. SIEMENS in the chair.

The following candidates were balloted for :

Associates.—M. A. Abrahamson, The Central Institution, South Kensington, S.W.; George Bloomfield Garvey, Thornvale, Moneygall, King's Co , Ireland ; Joseph Gritton, Messrs. Siemens Bros. and Co., Woolwich ; Edward H. Tyler, Stoneycroft, Beach-road, Weston-super-Mare.

Students.—Arthur Francis Berry, Faraday House, Charing Cross-road, W.C. ; Arthur Ernest Cullen, East Dene, Alexandra Park, Nottingham ; John Stanley Plumtree, 18, Peel-street, Nottingham ; Frederick Simpkin, Holling Bank-terrace, Heckmondwike, Yorks.

After the usual business a letter was read from the American Society of Civil Engineers, stating that the Institution had formed a small committee to give information to any members who might be visiting Chicago, and who required information at New York.

A letter of thanks was ordered to be sent by the secretary to the American Society of Civil Engineers.

Mr. Sparkes, in continuing the discussion on Mr. Snell's paper, described two motors designed by Mr. C. E. L. Brown—(1) a synchronous motor, (2) a non-synchronous motor. The synchronous motor had four field magnets, with coils in parallel, and armature with four coils in series. The E.M.F. was 92, and a periodicity of 40—a very low periodicity. On starting, armature and fields were in parallel, with a choking coil resistance in series. As the motor got into synchronism the resistance was cut out, and the belt was transferred from loose to fast pulley, and the full load might be put on—in fact, a heavier load might be put on without the motor getting out of synchronism. The motor ran quickly up to the normal speed of 1,200 revolutions. The second motor shown was of non-synchronous type, to give 120 volts with a periodicity of 50. Armature of sheet-iron stampings, with copper bars through them, connected at each end. The field magnets of this motor were similar to the armatures of the other motor, but with two sets of four coils. Mr. Sparkes, by means of diagrams, showed the sections of the machines. This motor would start from a countershaft. The results obtained from various sized motors were given, showing that the machine was a very efficient one. Mr. Sparkes thought Mr. Brown ought to be congratulated upon the great advance he had made.

Mr. Swinburne, like everybody else, had been exceedingly interested in alternating-current motors. The first motor Mr. Sparkes had described was really invented jointly and patented in the name of Mr. Swinburne. The speaker went a little into the history of these motors and referred to, perhaps, the earliest in this country, tried by him while at Messrs. Crompton's. He did not think it much use to have a motor with a periodicity of 40 here. The periodicity ought in England to be 100, and in America 120, probably everywhere about 134. The current required was against such a motor, but till it came that the current required was about the same as for continuous motors they were impracticable. With regard to the second motor, he thought that the design was anticipated by Leblanc, who had a two-phase motor and a condenser. There were, however, disadvantages which put such machines at present out of practical use. He thought there had been too much talk about double and triple current motors, but in most cases there was no exact idea of what was really wanted. He would like it to be decided as to which was the the field magnet and which was the armature in these machines. He proposed that the field magnets should be that part in which the magnetism of the iron was constant.

Mr. Mordey said the statement that the current in the motor was at a maximum when running light was not true. As to efficiency, he had shown synchronous motors nearly as efficient as continuous-current motors. The dead point was not a great difficulty ; it was not insuperable in engines and should not be in motors. English engineers were backward in these motors, as the present forms were a makeshift ; they would not take it up until motors ran on the ordinary mains. Motors now ran at 40 periods ; it would not be long before they ran at 100 or 130 periods. He objected to engineers trying to influence choice of system by saying motors could not be used on alternating systems. Motors were very little used—not 1 per cent. of total current. If alternate motors were perfect there was not yet much use for them. There was a great disadvantage of low periodicity. Their use on the Continent was because the apparatus used prevented structural difficulties for high periodicities. The key to the question was the transformers. Transformers were not as efficient at 40 as at 100 ⌒‿. It is not a question of design. Transformers built for 40 he found more efficient at 100. Most electrical work is lighting. He warned engineers against the fatal mistake of low period working—the motor difficulty was a temporary one. Transformers at low periods would waste power, and at 1d. per h.p. hour a watt would cost 1s. a year, probably in practise 3s. At 40 periods, therefore, you throw away money. Motors and transformers were much the same—both are transformers, and he thought it would be found for motors also low periodicities were no advantage.

Mr. Kolle said that at Chur there was at work a 3 h.p. self-starting single-phase motor working at 70 cycles. Ferranti's had a self-starting synchronous motor working in the London mains at 85 periods.

Prof. Ayrton began by saying little difference existed between so-called single-phase and the Drehstrom motors. The first were really two-phase, and the original motor devised by Ferraris. It mattered little whether difference of phase was obtained by advancing the phase by inserting capacity or retarding it by inserting self-induction.

Mr. Sparkes : The condenser is only inserted for one second. The motor is really single-phase.

Mr. Swinburne : Then it is practically an Elihu Thomson motor.

Prof. Ayrton referred to other points, and Mr. Snell promised to reply fully in the *Journal*.

On May 11 paper by Mr. Sayers on "Prevention of Sparking, Compounding, and Self-Exciting Dynamos without Commutator."

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NOTICE.

Several letters on "Educational Matters" and other subjects, as well as articles on a variety of topics, are unavoidably crowded out. With this issue every reader should receive a supplement of 16 pp. gratis.

COUNTY COUNCILLORS AND OTHER LOCAL AUTHORITIES.

Most people, except company-mongers, will now readily agree with the view that in certain directions it is better for the local authority itself to make provision for and supply the wants of the district, than to allow outsiders to provide that supply. It used to be said in olden days that light, air, and water were the natural perquisites of man, which, being natural products, costing nothing should also be obtainable freely without money and without price. The necessities of civilisation have changed all that. As yet air is free, but water and light are not. Broadly speaking, every local authority is concerned rather with the general than with the individual—the welfare of the whole community, and not the individual member, is its particular care. Hence its interest in artificial light, among other matters. Our opinion has been consistently expressed in that it was the duty of the local authority in all cases to undertake the provision of artificial light, and especially is this the case with regard to electric light. For some years the converts to these views were neither numerous nor eloquent, but gradually an overwhelming majority of the members of the industry, and of members of local authorities, have accepted the doctrine. The hesitancy of local authorities during past years was the natural result of imperfect information, added to the glaringly-inaccurate information, generally of the Arabian Nights' style, so freely disseminated by the political press. Gradually, however, the true education of the public is proceeding, and real information as to what may be expected, and what cannot be expected, is permeating through the ranks of local authorities. For some years the standing joke against the introduction of electric lighting was that it was in its infancy. No doubt experience was required to prove its trustworthiness, but that experience has long since been gained. The electric light is known to be safer and quite as trustworthy as gas, and no one now expects to have to combat views about "in" and "out"-ness. Of course a great deal depends upon cost—"initial cost" and "cost of maintenance." In this issue, which might be termed the county councillor's number, we have endeavoured to collect some information of the kind they require in their investigations. Mr. Russell has permitted us to give the contents of what will ultimately be a small pamphlet, embodying the general information which the members of local authorities desire to know when the question of electric lighting arises. Generally, the expert wants to explain too much. It may be held that Mr. Russell has explained too little. Upon such points opinions may differ; but if sufficient is told or said to enable the hearer or reader to form a clear conception of the matter, that is enough. The experts can deal with details. Broad facts, approximately correct, are what the councillor wants. The conclusion of Mr. Kapp's paper to the Society of Arts, the papers of Mr. Nicholson and Mr. S. A'Court, are electrical artillery directed towards the councillor. Mr. Nicholson claims to speak from his own experience, extending over many years, and therefore his figures should obtain careful consideration. They are favourable to electric lighting as against gas. Attention might, however, be called to variance in figures; for example, Mr. Scott Russell gives thirty watts per eight candle-power lamp, Mr. Nicholson thirty-three watts. This should not be taken as a divergence of facts, but is easily explained in that the former is speaking generally and approximately, while the latter is dealing with more exact figures. It will be well if electric light engineers in the future restrict their figures more to those given from actual results than to those obtained from estimates. While we deprecate the comparison between gas and electricity, it is solely because electricity never gets fair play. It possesses advantages—aye, and economical ones—that are rarely set forth in such comparisons. Yet it has little or nothing to fear from even a strict comparison in price, as will be seen from Mr. Kapp's figures in connection with the installation at Madame Tussaud's and other private installations. If further information suitable to impress householders is needed, it will be found in a short article by Mr. W. J. Rivington in the *Queen* of April 22, wherein he sets out that the cost of electricity in a given house with ninety-one lights is one-tenth less than the cost of other artificial light by gas, oil, and candles. Every succeeding day points to electricity as having no superior as an artificial illuminant. It is safe, pleasant, and, if used on a large scale, can be made cheap. Local authorities who have the welfare of their districts at heart should not procrastinate. They can borrow money cheaply, they can do the work well, and, above all, can introduce the greatest aid towards sanitary perfection the world has ever known. We think much of the use of electricity for lighting purposes—it will come to be used more for power purposes. And it ought to be used in every house for sanitary purposes. Nascent oxygen is the great disinfectant. There is no reason why every cistern and every filter should not be fitted with electrodes, so that the contents be constantly saturated with nascent oxygen. The air of every drain and pipe could similarly be purified. The cost will be much less than a doctor's bill.

NOTES ON THE COST OF ELECTRIC LIGHTING.[*]

BY F. B. NICHOLSON.

The author's object in bringing a paper of this nature before you is threefold: first, to lay before you his own experience on the subject, and the deductions he draws therefrom; secondly, to give rise to a discussion and elicit the experience of others; and thirdly, to try and formulate his own data in such form that it may be of some utility to those members of the society who, though not electrical engineers, yet may be called upon to advise clients as to the adoption of electric lighting, and give them some fair idea of what should be paid for the work they may want carried out. In the figures given, the author has been entirely guided by his own experience, which has been of a somewhat varied nature, and extends over a period of 17 years, and he has been encouraged to put forward his experience by the strange lack of information which has been made public as to actual cost. I do not mean to say that details have not been given in the technical papers as to the estimated cost, but would only like to point out that estimates, especially in a new business, are not always reliable, and he therefore prefers to confine himself to facts.

The question has often been put as to why, when tenders for electrical work are invited, prices are received showing such large variations, and the author has had to give as reasons one of the following: first, there has been no specification, in which case each firm will tender in accordance with its own ideas, which are not likely to agree exactly with those of any other firm; secondly, firms tendering who know little about estimating, and who give prices in a somewhat haphazard way; thirdly, some combination of the three causes.

In cases of ordinary housework, when a man decides upon lighting his house with electricity, he generally asks his friends to recommend him to someone (that is to say, if he is one of those individuals who does not happen to have a relation in the business) and they all recommend different people. He gets in prices from them all, and gives the job to the man who talks to him nicely and bothers him most. There seems to be a very prevalent notion amongst many people that an electric light will do so very much more than a gas light, leaving out of the question altogether any consideration of the relative candle-powers. For instance, in one place I was in lately the occupier of the premises had 14 6ft. gas burners in use, and suggested that I should replace them with two incandescent lamps—he evidently was thinking of arc lights. Now, this point is a most important one, considered as bearing upon the question of economy in using the electric light. The author finds that when replacing gas in houses, a lamp of 8 c.p. can generally be substituted for the ordinary gas-burner, and this lamp takes as nearly as possible 33 watts, and if the supply company charge 6d. per unit, as many of the companies now do, we shall get the cost of an 8-c.p. lamp as ·1998d. per hour, and adding to this meter rent and renewals of lamps, will bring the total cost as near as possible to ·23d. per hour, or rather under ¼d. The gas-burner which this will replace will consume between five or six cubic feet of gas per hour, and the cost of this, with gas at 3s. 2d. per 1,000 (which is the price the author pays), will be ·211d. per hour, so that the cost of electric lighting under these circumstances will be about 10 per cent. in excess of gas. Table A will show how far some of the receipts of the London companies agree with the view taken. Table B will show two or three actual bills of clients of the author, and it will be seen that the results show very fair accordance with the figures given.

In office lighting it will be found that rather different circumstances prevail. Eight candle-power lamps will not meet the requirements of most cases, and 16-c.p. lamps will be almost universally required, as offices generally use argand or some other improved burner, which gives much more light than the ordinary household burner. Under these circumstances electric lighting will cost more than gas in the proportion of approximately 4 to 3. Exact figures cannot just now be given on this point, as the City offices, from which the figures are being obtained, have not been using current long enough to get a fair average, but the author proposes at some future meeting of the society to lay full details before it

Factory Lighting.—There is the utmost difficulty in giving any reliable figures relating to this, as so many plants are run from the factory engines, which makes it impossible to arrive at the exact cost of the power. In very many cases the power for the lighting is not considered to cost anything, as there is a margin of power both in engines and boilers, which, when used for the production of electricity, is so small a fraction of the total power developed, that it does not appreciably affect the power cost, and as the attendance to the plant is carried out by the men already on the premises, the total cost is measured by renewals of lamps and repairs to plant. It need hardly be said that in such a case the cost comes out at much below other illuminants. The author would here like to draw the attention of engineers to the power absorbed in shafting erected in the old style in rigid bearings, as it will be found that 50 or 60 per cent. of the indicated horse-power of the engine is being used in turning the engine and shafting when the engine is working up to its full power. In such a case the adoption of modern improvements in hangers, etc., would give us plenty of power for the whole lighting of the premises without any increased cost for power.

The author has had a good deal of experience in arc lighting, and it is here that the greatest differences arise as to the cost of running. At a lighting station where the author was some three or four years, it was found that 500-watt lamps could not be run (during ordinary lighting hours for streets in England) under £22 per lamp per annum, whereas there is in England a large works where for the same period of running the cost comes out at something like £8 per lamp per annum; the latter case is, however, a very exceptional one, as everything is on a large scale and no money is spared to keep things in a high state of efficiency.

Under ordinary circumstances in works where engines are on the premises, it may be fairly estimated that each 500-volt arc lamp can be run at 1d. per hour, but this is of course an approximate figure varying very much with the circumstances of each special case.

First Cost.—The cost of a number of different installations is shown on Table C, and the author finds that in order to get anything like a comparison it is necessary to divide it into sections.

Section 1.—Including mains to lamp, wood casing, and labour in putting up. The wires throughout being of Messrs. Henley's Class A, which has an insulation resistance of 2,000 megohms per mile. This is an especially high-quality cable, which the author has used for several years, and it has given him very great satisfaction. (In mentioning this make of wire the author does not mean to infer that there is no other make of wire equally good.)

The average cost, including labour in putting up (no plugging of walls being required, and the switches being arranged in lampholders) comes out at 16s. 4d. per 16-c.p. lamp, and this price should allow a fair profit to the contractor. If the switches are placed on the walls away from the lamps the cost will be increased to 18s. 5d. per lamp, as more labour and material will be required.

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[*] Paper read before the Civil and Mechanical Engineers' Society, April 6, 1893.

It is assumed that these lamps are all one floor, and where there are several floors the cost of mains connecting the floors to distributing-boards must be added.

In practice the author uses the following formula : $\frac{L \times c}{125} = A$, where L equals total length of lead and return in feet ; c, current in amperes ; A, area of copper in square mils to give a loss of one volt for given length and current.

The following table will give the cost of these mains, and will be correct for a distance of not more than 21 yards, as for this distance with the maximum current they give a loss of one volt. The size for shorter lengths cannot be reduced, as this would be using cables of smaller sizes than are allowed by the fire office rules—viz., 1,000 amperes per square inch :

Number of 100-volt 16-c.p. lamps.	Cost of mains per yard run.
21	2·5d.
38	3·4d.
48	3·9d.
60	4·4d.
104	6·10d.
152	8d.
160	9·3d.

We next have the distributing-boards with double-pole fuses for each circuit, and these mounted on enamelled slate and fixed in position will be reckoned at 6s. per way for circuits each taking a maximum of 10 amperes. If they are enclosed in glass cases an extra allowance must be made for this. The next point will be the fitting. In ordinary housework the nature and style of brackets and electroliers vary so widely that the author cannot give any nearer information than that £1 per lamp for this item alone should provide good plain brass fittings (polished), and would be a fair allowance to specify as a provisional article—this amount may be exceeded of course. The universal fitting, however, appears to be the plain suspension with switch in holder, and the cost of these with a white porcelain ceiling rose 2½ft. in diameter mounted on a hard wood block, a 6ft. length of vulcanised silk-covered flexible cord, a white opal shade 9in. in diameter, and a lampholder with switch, and labour in putting in same will be 8s. 9d. To this must be added the lamp at market price, at present 3s. 9d., making a total of 12s. 6d. If the switches are on the wall they will make a saving in the lampholder of 2s. 3d., but against this must be put the increased cost of wiring, 3s. 1d. ; so that we really get an increased cost of 10d. in the wiring, and in addition we have the cost of the switch. These also vary somewhat in price, but I may say that a good switch in white porcelain mounted in walnut block and fixed in position is worth 3s. 3d. The cost of the small fuse should be taken at an average of 10d. per light erected. When we add to the above figures the cost of any mains, switches, and fuses required, the total cost is arrived at.

It, however, must be remembered that no allowance whatever has been made in the above figures for any special work, such as cutting through thick walls, and making good, which may increase the cost of mains considerably, in some cases as much as 2s. 6d. per yard.

It, however, will generally be safe, when there is only an ordinary amount of cutting away to do, to reckon this item at 9d. per yard of cables ; when several cables run side-by-side, this should not be reckoned in each separate cable, but an allowance should be made to cover the whole of them. The best work only should be used, the lights subdivided into as many circuits as can be conveniently arranged, and double-pole fuses to each circuit ; then if an accident happens to any circuit it can be disconnected and repaired without affecting the other circuits.

TABLE A.—Average receipts per annum per 8-c p. lamp obtained by the various electric light companies in London districts

	1892.		1891.	
	s.	d.	s.	d.
Westminster Electric Supply Corporation.	9	7	—	
Chelsea Electric Supply Company	7	7	—	
St. James's and Pall Mall Electric Supply Company	19	5	—	
Kensington and Knightsbridge Company	7	9	—	
Electric Supply Corporation	—		12	3
Metropolitan Electric Supply Company	—		11	7
House-to-House Electric Supply Company	—		9	3
Electricity Supply Corporation	16	11	—	
Notting Hill Electric Supply Company	7	6	—	

The cases of such companies as the St. James's and the Electric Supply Corporation cannot be taken as a criterion of the cost of general lighting, as in both instances very exceptional conditions obtain ; the districts supplied being well furnished with consumers who burn their lights for exceptionally long periods. It may be taken, on an average, that each 8-c.p. lamp installed will cost 8s. per annum for current.

TABLE B.

43 lights, 8 c.p. in private house where lights are used late, the supply company's charge being at the rate of 7d. per unit, from September, 1891, to September, 1892	£16	11	3
Private house, at 7¼d. per unit, 25 lights, one quarter *to* December	4	1	11
At 7¼d. per unit, 69 lights 8 c.p., one year	41	9	7

TABLE C.—Cost of Installation.

Office lighting in building during construction, switches in walls, but only 22 lights	£19	19	4
Private house, finished, but not decorated, 57 points, 68 lights	50	10	9
Furnished flats, no fittings, 17 lamps	20	3	8
With all fittings.			
Office, nine suspensions, five brackets, 14 lamps	22	5	4
Office, one floor, and short main, four lights, all suspension	6	10	2
Factory mains, four floors, mains to each floor, and extra main connecting two buildings, 120 lamps	234	14	6
Office, one floor, 22 lights, switches in holders	33	0	0

GAS v. ELECTRICITY FOR ILLUMINATING PURPOSES.*

BY S. A'COURT, A.M.I.C.E.

In choosing this as a subject for a paper, the author was to a extent influenced by an article in a recent number of the *Journal of Gas Lighting*, in which, to his thinking, the matter was not fairly considered. He has therefore collected information on the rival illuminants, and done his best to put before this society the merits and demerits of each.

To begin with the production of gas at the works. Until quite recently gasworks managers were able to sleep peacefully at night, and not trouble about economy of production, but since the recent strikes, and now that the supply of cannel is running short, it is a different matter. Water-gas and enriching-plant experiments are costing gas corporations many tens, if not hundreds, of thousands of pounds, and as yet we have no published accounts of any system proving a success. Electricity depends for its generation on power plant only—water power, steam power, wind power, anything will do. Steam can be raised quite well from any oil or non-illuminating gas, and therefore as regards the future we need never be afraid of being unable to keep our dynamos running.

Taking first of all the public lighting of streets and squares of London, we find that no two parishes are alike in the amount of light per unit area of streets of equal size, nor do they agree in the actual positions of the lamps. In St. Pancras we have arc lamps on posts in the centre of the main thoroughfares, thus imitating the lighting of many European towns ; while Westminster is seemingly content with gas lamps in the centre of the road and also along the edges of the pavements. It will, at all events, be admitted that the tendency of the age is towards better lighting of thoroughfares, for the life of the London streets is quite as brisk at 6 p.m. as at 2 p.m., and while in the good old-fashioned days that we sometimes hear about, our grandfathers were content to remain at home at nights, or only wander to and from the nearest tavern, we now require light, and plenty of it, up to, say, midnight.

Gas lamps have lately been much improved as regards the amount of light they give, and the reflectors fitted to the lanterns distribute the light well. The three and five-burner lights in Westminster take 30ft. and 50ft. respectively, which, at three candles per foot, means 90 c.p. and 150 c.p. The makers claim 270 candles for the 50ft. burners, or 5·4 candles per foot, but the author has not been able to discover any proof of this statement. Arc lamps burning with 10 amperes and 45 volts have been tested photometrically and found to give 1,500 c.p. at 45deg. What we really require is a good and well-distributed light at a low cost to the ratepayers.

All lighting engineers owe a great debt of gratitude to Mr. A. P. Trotter for his experiments in the distribution of light in our streets, recently carried out by him in London with the aid of his portable photometer. The results prove how irregular street-lighting is. Mr. Trotter found that the illumination given by bright moonlight in London is practically $\frac{1}{30}$th candle foot, or, say, ·034 candle foot, and this should be the minimum illumination for any street, while main thoroughfares should have not less than ·1 candle illumination. It is evident, therefore, that while for small streets gas lamps of 12 candles, with those of 90 candles at crossings and refuges, will give sufficient light, yet, when we take important streets, the number of high-power gas lamps required to give proper illumination means a large initial outlay, and a heavy bill for running cost.

A 10-ampere arc lamp complete with post and lantern, costs £18. 10s. A 50ft. gas lamp complete, with lantern and post, costs £14. 11s. The contract price per arc lamp per annum for current, cleaning, carbons, and repairs in London and other towns is £26, all-night schedule. A 50ft. gas-burner on all-night schedule, with gas at 2s. 2d. (London Gas Light and Coke price), will cost £23. 8s. for gas alone, and, adding cleaning, lighting, and renewals of broken glass and reflectors, the total comes out practically £25 per lamp per annum. Here, therefore, we are actually paying the same price for practically one-tenth of the light. It is true, however, that, excepting where we have arc lamps in the centre of the roadway, a great portion of light is more or less wasted on the side of the lamp towards the houses bordering the streets, and therefore to compare the two lights we have to allow for some waste. It has been found that to secure good lighting 10-ampere arc lamps are required on both sides of the streets, placed at a height of 25ft., and at a distance of not exceeding 150ft. apart, measured from lamp to lamp on the same side. When streets exceed 50ft. in width it is necessary to reinforce the lighting with arcs on central refuges.

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* Paper read before the Civil and Mechanical Engineers' Society.

Now, in order to give an equal lighting effect with gas, it is found that high-power lamps have to be placed in groups of three on refuges, and placed at about 50ft. apart along the sides of even 40ft. streets. The distribution of light from high-power gas lamps is so different from that given by an arc lamp that it is difficult to fix any exact ratio for equal lighting effect; but roughly speaking, yet making every allowance for gas, five 50ft. gas-burners are required as against every 10-ampere arc lamp. On this basis the first cost of each for equal lighting effect comes out to be: electricity 1 to gas 3·9, and running expenses 1 to 4·8. It is therefore clear that for proper illumination of main streets there is no comparison in either first cost or annual expense. The electric light is enormously cheaper. In small streets, where lamps serve only as buoys to mark out the channel, gas is cheaper than incandescent electric lamps of equal power (12 candles); but before long we shall be wanting better illumination of small streets, and then it may be found that, if the power of the lamp is raised to 50 candles, electricity can compete, and that favourably.

As in London we are unfortunately only too familiar with fogs, and those of the deepest dye, the author has had ample opportunities of studying the effects of the rival illuminants under such conditions: on one occasion driving along Piccadilly at 10 p.m. in a dense fog, in November, 1892, it was impossible to see any other lamp light whatever when standing on the kerbstone under a gas lamp, while during the same fog it was possible to steer in Parliament-street or Queen Victoria-street, proving that the illumination of those two streets was rightly adjusted for the maximum requirements.

For the illumination of railway stations it appears that arc lamps have practically superseded gas, probably for convenience in handling goods and loading and unloading passenger trains, when a great deal of light is required. But it is when we come to domestic lighting that the greatest difference is apparent. Arc lamps are unsuitable, except for shops or large offices, and electric incandescent lamps or gas-burners have to be used.

The gross revenue derived from each 8-c.p. incandescent lamp connected to a supply company's mains in London varies from 18s. 6d. to 7s. 6d., but it is found that 10s. per lamp is the average for private houses. The revenue for gas lamps of 8 c.p.—*i.e.*, the ordinary 4ft. Bray burner—comes to about 10s. This has been calculated from Mr. Newbiggin's book, gas being taken at 2s. 4d. Renewals, supposing ordinary gas-burners to be used, come much higher for electricity; but if Welsbach or any regenerative or argand burner is used the difference is not so great, if we include cleaning and renewal of mantels and glasses, and take interest on first cost into consideration. With ordinary care an eight-candle electric incandescent lamp will last about two years without renewal, or, say, 1,200 hours, giving an average throughout of seven candles, the depreciation being due to blackening of the interior of the globe. A No. 4 Bray gas-burner, when clean and new, with 16-candle gas and 1½in. pressure, will give 12 candles, and last about the same time as an economical burner.

The chief differences between gas and electricity may be summed up as follows, putting *pros* and *cons.* fairly side by side:

Gas.	Electricity.
1. Costs one-third less for equal light.	1. Costs more for burning.
2. Equal cost to instal in old or new house.	—
3. A leak is dangerous:	3. A leak:
(*a*) To health.	(*b*) May cause fire.
(*b*) May cause fire	
(*c*) May cause explosion, generally followed by fire.	
4. Heats and vitiates the air.	4. Heats the air slightly.
(*a*) When vitiated the light is depreciated—thus, with:	Not affected.
·26 % of CO_2 — 5·7 % less.	
·60 % ,, — 20 % ,,	
1·26 % ,, — 100 % ,,	(No light)!
5. Matches required for lighting.	5. Turn a switch.
6. Not good for decoration.	6. Adapts itself to any decoration.
7. Steady light when not burnt in a draught.	7. Steady light under all conditions.
8. Most convenient for cooking and heating, though very expensive.	8. Not yet practically employed for either.
9. Must be laid so as to avoid any syphon, and is badly affected by frost.	9. Conductors can be laid in any way, up or down, and frost has no effect.

Without doubt the ordinary Bray gas-burner is cheaper than an electric incandescent lamp for equal candle-power as regards the actual cost of gas or current, but a paraffin lamp is again much cheaper than gas.

It is inaccurate to state that the steady annual increase in the amount of gas sold is because of its cheapness—the reason is, that electricity has shown people what a good light really means, consequently our streets and houses are better lighted, and therefore we now have the enormous increase of high-power public gas lamps.

REGULATION OF SUPPLY AND PRESSURE.

There is one most important point which is not sufficiently appreciated, and that is the apparent incapability of gas companies to supply gas at equal pressure all over the district they serve, much less to keep the pressure constant at any point. The Gas Works Acts are a useful piece of legislation, but require a supplemental Board of Trade Order to enforce supply at constant pressure. Electricity under the Electric Lighting Acts must be supplied with a maximum variation of 2 per cent. either way. The author has been unable to find any information as to the variation in candle-power due to this 2 per cent. variation in incandescent lamps of varying power, nor has he either been able to discover much about the effect of varying pressures on gas-burners, except only a test by Dr. Wallace in 1880, which was as follows:

Gas 26 c.p., No. 4 batswing burners.

Pressure.	Gas.	C.P.
·5	1·9	23·05
1·0	3·10	20·5
1·5	4·0	19·26

If this proves anything, it means that at the time of greatest load the ordinary small consumer, with no patent regulator, gets 15 per cent. less light, and pays 100 per cent. more for it. The author recently recorded a difference of nearly 100 per cent. gas pressure in Westminster in one hour's time, and in the City of from 24 to 30 tenths in half-an-hour. It is quite true that gas regulators are largely used, but it is not fair that they should have to be found by the consumer, nor are they perfect, at least so far as the author has yet found. As to the quality of the two illuminants, gas only can vary, and does so, notwithstanding gas inspection; this is another point in favour of electricity, which can only be of one quality.

METERS.

This is a sore point all round for the poor consumer. To "lie like a gas-meter" is unhappily a proverbial saying, and is borne out by facts. The author recently had occasion to analyse the tests of 400 gas-meters of all sizes, taken as they came in for testing or repairs, with the following results:

		While permitted by the Act.	Greatest errors were
Average slow...	3·57 per cent	slow 3 per cent.	fast 16·63 per cent.
,, fast ...	4·07 ,,	fast 2 ,,	slow 10 ,,

Total against consumer ·5 per cent.

This is good from the point of view of anyone of an analytical turn of mind, so long as he is not the happy possessor of a meter 16·63 per cent. too fast. Electricity meters are a comparatively new invention, and as such they are by no means perfect.

As an instance of the way in which electric supply companies appreciate the matter, the author may mention that one of the largest supply companies of London never leaves any meter (on a consumer's premises) beyond 18 months without replacing it with a newly-tested one, while all meters as they come in for testing are entirely taken to pieces and cleaned before retesting and sending out. If gas companies did the same we should hear of less trouble. The Board of Trade has up to now refused to accept any type of electricity meter as complying with their requirements, in order to be accepted as a certified form of meter; whether the fault lies with the Board of Trade in not knowing what they require, or the meter manufacturers in not being able to understand what is required of them, is outside the scope of this paper, but at all events were we to see an ancient gentleman wandering about the world with lantern in hand, we should at once be able to spot him as a Board of Trade philosopher following the example of Diogenes, and searching hopelessly for an honest meter, whether gas or electric.

Electricity has a great and near future in providing the best form of illuminating agent, as any impartial student can easily see, while gas will always be of great service for heating, cooking, and motive power. In fact, at a no very distant date we may find gas companies supplying non-illuminating gas, only for heating and cooking, which would to a great extent do away with the "yellow" of a London fog, and the gas, if supplied, as it probably could be, at 4d. per 1,000, could be burnt under the boilers of the electric supply companies, and produce cheap electric light and power.

SOME ECONOMIC POINTS IN CONNECTION WITH ELECTRICITY SUPPLY.*

BY GISBERT KAPP.

(Concluded from page 412.)

POWER AND CAPACITY OF BATTERY.

In a private installation for domestic purposes, a storage battery is an absolute necessity. The owner of such an installation naturally expects to get the light at any hour of the day or night, and this requires some system of storage. The question is, How much storage? If the battery is small, the interest on capital outlay on account of the battery will also be small, and to this extent the working cost will be reduced. But, on the other hand, we must remember that a small battery is liable to be overworked, and will then deteriorate more rapidly, so that the cost of maintenance will be increased. It will also require more frequent charging, thereby bringing up the cost of labour. A further disadvantage is that, as already pointed out, the engine, when charging, will be worked much below its power, and therefore with low efficiency. All these defects are materially reduced if we instal a large battery; but in doing so we increase that part of the working cost which is due to interest on capital outlay, and it is obvious that before deciding on the best size of battery (as defined by its power and capacity), we must take very careful account of the local conditions in each particular case, such as cost of fuel, lighting hours, cost of labour, proportion of lamps lighted to lamps, fixed, etc. Generally speaking, if the domestic installation is very large, the capacity of the battery should be comparatively small, and its power moderately large. We would in such a case employ a battery of small size, but capable of giving a rapid discharge. In small domestic installations the battery should have a comparatively large capacity, and we would employ a kind of cell which is less liable to deterioration when left charged for long periods. In private installations for business purposes, the amount of light required outside of business houses is very trifling, and the battery may therefore be small. We would then arrange the installation to do nearly the whole of the lighting direct from the dynamos. and use the battery merely to steady the voltage and as a limited reserve in case of breakdown of machinery. The necessity of running daily will of course increase the wages bill, but as the total amount of light required is large, an extra pound or two per week for wages does not materially increase the working cost per unit. In certain cases it will even be advantageous to work without a battery, and to provide against a breakdown by splitting up the generating plant into two or more units of suitable size.

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* Paper read at the Society of Arts on Wednesday, April 17, 1893.

LOAD FACTOR.

I have, in the foregoing remarks, briefly alluded to some of the features in private installations which affect the working cost, and have attempted to show that each installation, in order to work economically, must be designed with due regard to its special requirements. To use the same type of plant, and work it in the same way in every case, would be bad engineering. in the same way as it would be bad engineering to apply the same system of central-station supply to every town or district, regardless of the special and local conditions in each case. By careful attention to the special requirements, we can then bring down the working cost per unit to a minimum, but whether this minimum be high or low will depend on a circumstance which is beyond our control, and this is the extent to which the plant is used. It is evident that the more steadily and continuously any given plant be used, the greater must be the economy in working; or, to put it in another way, the smaller will be the cost per unit supplied to the lamps. Mr. Crompton has introduced the term "load factor" to express generally the extent to which central-station plant is usefully employed, and the term may be defined more precisely in various ways. I shall here use it for private installations, in the sense of expressing the ratio of the actual yearly supply to the lamps to the supply which would be required if the maximum number of lamps alight simultaneously at any time were kept alight over one year. To make this definition quite clear, let me take an example. Assume that, in a country house wired for 100 16-c.p. lamps, the maximum number ever alight simultaneously is 70, with an observed output from the generating plant of 5½ kilowatts. If the plant were kept working day and night at this rate for one year, the total supply to the lamps would amount, in round numbers, to 44,000 units. Suppose you put a meter into the supply circuit, and that meter registers actually only 3,500 units in one year, then the load factor of the installation would be $100 \frac{3,500}{44,000} = 8$ per cent. The influence of the load factor on the working cost per unit is very great, as you will see from the examples of private installations which I shall cite presently. The load factor is, however, not under the control of the engineer who designs the installation; it is fixed beforehand by local conditions, and for this reason it is all the more important that these local conditions should be taken very carefully into account in deciding the various points to which I have already referred, so that the owner may get the required amount of light for a minimum of annual expenditure

USE OF METERS.

Private installations are generally supplied with the necessary instruments to indicate current and pressure, but the cases where an electricity meter is used are extremely rare. A meter of this kind is, from the contractor's point of view, not necessary for running an installation, and will, under a competitive system of tendering, not be supplied unless the owner is willing to pay for it as an extra. From the owner's point of view a meter is, however, exceedingly useful, as it enables him to detect waste, and keep the engineman and his machinery up to the mark. There is something illogical in the way most private installations are worked. The owner knows, or at least has the means of knowing, how much fuel and stores he uses, but he is entirely in the dark as to how much electricity he gets in return. It is as though a merchant kept only one side of his ledger posted up. If a meter be installed, and its readings are frequently compared with the amount of fuel used, the owner will be in a position to determine by actual experience the most economical way to work his installations, and he will be able to detect it at once if his engine, or dynamo, or battery begins to get out of order. Where a battery is used there should be two meters employed, one measuring the whole of the supply coming from the dynamo, and the other the whole of the supply given to the lamps. The cost of the two meters is so trifling in comparison with the saving in working expenses, that no installation should nowadays be put up without meters.

EXAMPLES.

By the kindness of various electric light contractors, and owners *of private installations, I am able to* place before you the actual

TABLE A.—COST OF ELECTRIC SUPPLY IN PRIVATE INSTALLATIONS

Owner of installation.	Equivalent number of 35-watt lamps fixed.	Capacity of generating plant in kilowatts.	Maximum load observed in kilowatts.	Total number of B.T.U. used per year.	Number of B.T.U. used per 35-watt lamp.	Load factor per cent.	Plant.			Cost per B.T.U. in pence.								Pounds of coal used per unit in lamps.	Cubic feet of gas per B.T.U.		Price of gas per 1,000 cubic feet.	Premises lighted.
							Number of engines.	Number of dynamos.	Sets of batteries.	Coal or gas.	Stores.	Repairs.	Wages and superintendence.	Water.	8 per cent. on cost of plant for interest & depreciation.	Total cost for generation.	Lamp renewals		Generated.	Used in lamps.		
General Post Office, London........... ...	75,000	250	190	660,473	88	39·7	5 steam	5	none	·623	·601		·863	·0378	·35	2·475	—	5·8	—	—	—	Government buildings.
G.P.O. Savings Bank Department......	2,400	100	50	118,427	49·5	22·6	2 steam	2	none	·948	·295		1·413	·122	·65	3·428	—	8 85	—	—	—	
Madame Tussaud and Co., London.....	1,090	40	32	72,224	66·3	25·8	2 gas	2	3	1·28	·235	·705	·6	—	·58	3·40	·283*	—	37	39	2s. 9d.	Exhibition.
Messrs. Bainbridge and Co., Newcastle-on-Tyne........	1,300	50	45·6	50,850	39·1	12·7	3 gas	3	none	·80	·038	·066	·390	·071	·49	1·855	·182	—	40·5	40·5	1s. 7¾d.	Shops and workrooms.
Constitutional Club, London	1,600	100	45	116,900	73 2	29·6	3 steam	3	none	—	—	—	—	—	—	—	—	—	—	—	—	Club.
Arts Club, London	248	5·5	4·8	10,800	43·5	25·6	1 gas	1	1	2·66	·233	·111	·80	—	·922	4·726	·300	—	—	80·7	2s. 9d.	Club.
Duke of Fife, London	720	17·5	10·6	3,600	5·0	3·87	1 gas	1	1	1·45	·5	·133	5·000	—	4·52	11·603	—	—	—	—	2s. 9d.	Private house.
Sir David Salomons, Tunbridge Wells.	300	—	7·0	4,390	14·6	7·1	2 gas	sev'ral	2	3·22	·09	5·62‡	2·27	—	6·8	18·00	·103	—	—	85	3s. 2d.	Private house.
Mr. C. W. Mitchell, Newcastle-on-Tyne†...	480	17	13	4,720	9·82	4·15	1 gas	2	1	2·14	2·19		2·04	—	4·04	10 41	—	—	—	97	1s. 7¾d.	Private house.
Mr. W. H. Preece, Wimbledon	70	2	2	1,120	16	6·4	1 gas	1	1	7·38	·79	·95	2·22	—	7·1	18·44	1 28	—	—	144	4s. 3d.	Private house.
Mr. S. E. Phillips, Blackheath	74	3	2·2	1,448	19·6	7 5	1 gas	1	1	3·4	·16	—	2·58	—	5·8	11·94	·745	—	75·5	113	2s. 6d.	Private house.

* Including carbons for arc lamps.

† The figures are based on estimates given by the owner; the installation is now supplied by the Newcastle-on-Tyne Electric Lighting Company.

‡ Including an estimated annual cost of £100 for renewal of batteries.

working cost of such installations. The list is not as complete as might be wished. but it is difficult to obtain information of this kind, for the reasons already stated—namely, that the use of meters is generally considered a superfluous luxury. In a few cases meters were not used, but the output was regularly booked from time to time, and the total ascertained by summation. The results are given in Table A, and to prevent misunderstanding a few words of explanation are necessary.

The total capacity of the installations is given in 35-watt lamps. There are, of course, in many cases incandescent lamps of a different power, and in some cases also are lamps installed; but, as it was necessary to bring all the installations to a common standard, I have selected the 35-watt lamp as the unit, and the number in the first column has been calculated by dividing by 35 the number of watts required collectively by all the lamps actually installed. In the column headed "Capacity of Generating Plant" is given the output in kilowatts, represented by all the engines and dynamos installed, irrespective of batteries. The next column gives the maximum observed load, and the ratio between this and the total generating capacity shows to what extent the machinery installed is really required. When the ratio approaches unity, the amount of reserve plant approaches zero, and this in an important installation is not desirable, although in a small private installation the necessity of having reserve machinery to guard against a breakdown is not so great. On the other hand, if the ratio is too low—that is to say, if we put in a great deal more generating plant than is actually required—we burden the installation with a uselessly large annual outlay for interest and sinking fund. The total units supplied during the year are in most cases actually metered, in some cases they are compiled from the entries at regular intervals of current and pressure in the log-book of the installation, and in one case they are deduced from the statement of the owner as to the average number of lamps alight and time of burning.

The annual working cost is made up of the actual expenditure for the following items: Fuel, oil, waste, and petty stores, given under "stores," wages and supervision, repairs, water, and a charge of 8 per cent. for interest and sinking fund on the cost of the generating plant. No account is taken of the cost of wiring, or fittings and lamps, because these items would be equally required were the current obtained from a supply company, and my object was to get a fair basis for comparing the cost of electricity made on the premises with that of electricity supplied from a central station. The result of this comparison is, roughly speaking, this. Electricity made at home for domestic purposes costs about twice as much as electricity supplied from a central station, but if made at home for business purposes it costs only about half as much. A few remarks on the more important installations given in the table may be useful.

General Post Office.—I am obliged to Mr. Preece and Mr. Probert for the following figures, referring to the installation at St. Martin's-le-Grand and at the Savings Bank. At the former there are five and at the latter two steam dynamos of 50-kilowatt output; no batteries are used in either case. The cost of stores includes not only all engine-room stores, but also renewal of lamps, wiring, fittings, and all repairs. In the general table I have deducted ·3d. on account of lamps and fittings, but here I give the figures as given me by Mr. Probert:

	St. Martin-le-Grand.	Savings Bank.
Number of 16-c.p. lamps installed	3,750	1,200
Units	660,473	118,727
Cost of fuel per unit	·623	948
Cost of stores per unit	·901	·595
Cost of labour per unit	·863	1·413
Cost of water per unit	·0378	·122
Total per unit	2·4243	3·078

The amount of coal burned per unit is in the two cases respectively 5·80lb. and 8·85lb. You will see from these figures that the Post Office, by using home-made electricity, obtain their light at less than half of what it would cost them if they obtained the supply from a company.

Madame Tussaud and Son, Limited.—In this case the motive power is gas, and batteries are used to a limited extent. The capital outlay for machinery and wiring is a little higher than would be the case in an ordinary business installation, and this is mainly due to the extra precautions taken against accidental extinction of lights. Each room in the exhibition is lighted from three independent circuits, two being main circuits, and the third a panic circuit worked from an independent battery. The switches are so arranged that a failure of either or both engines does not effect the panic lights. In designing the installation I adopted this arrangement because the effect of a panic in a place frequented by bank holiday crowds would be very serious. On the other hand, this and other precautions increased the capital outlay, so that the item for interest and sinking fund in the annual working expenses is larger than would be the case in an ordinary business installation, where such elaborate provisions for the public safety need not be made. The total cost of the installation was in round figures £4,000, of which £2,100, or about £42 per kilowatt capacity, was expended on generating plant. Towards the end of 1891—that is, after the installation had been at work for over a year—I was asked by the directors of the company to generally superintend the lighting, and the installation has since then been under my charge. By the kindness of the directors I am able to give you the exact working cost for the year 1892, which, for a total supply of 72,224 units to the lamp, was as follows:

Gas (2,817,000 cubic feet at 2s. 9d.)	£387	6	6
Engine stores	66	5	3
Repairs	141	15	0
Dynamo stores	5	2	6
Battery renewals	70	19	1
Wages and superintendence	179	0	0
8 per cent. interest and sinking fund	168	0	0
Total	£1,018	8	9

The amount for wages and superintendence actually paid amounted to £279; but as this figure includes alterations of lamps, and putting up of new lamps, of which about 50 are added every year, I have deducted £100 on this account.

The item for engine repairs is exceptional. On being consulted about the installation, I found it necessary to have the engines thoroughly overhauled; but this expense will, of course, not have to be incurred every year. The plant is now in charge of a very efficient attendant, so that the repair bill for this year will be materially reduced. The best record of gas consumption in winter is 33 cubic feet per unit generated, and the average record over the whole year is 37 cubic feet per unit generated, and 39 cubic feet per unit supplied to the lamps. The total working cost amounts to 3·4 per unit supplied to the lamps, being about half what the supply from a central station would cost.

The total annual cost for lighting, including lamp renewals, interest, and sinking fund for wiring, alteration of lamps, and putting up of new lamps, amounts to £1,350. It is interesting to compare this figure with the cost that would be incurred were the whole exhibition lighted by gas. For this purpose I assume that each cubic foot of gas burned in argand burners gives three candles for one hour. The total light now supplied per annum is 26 million candle hours. With gas the account would stand as follows:

Gas bill (8,650,000 cubic feet)	£1,190
Renewal of burners, glasses, shades	40
Alteration of lights and new lights	100
Wages for cleaning and repairs	100
8 per cent. interest and sinking fund on £1,500	120
Total	£1,550

That is, £200 more than the electric light costs.

Messrs. Bainbridge and Co.—This installation was designed and supplied by Messrs. J. H. Holmes and Co., of Newcastle, to whom I am indebted for the following information. The generating plant consists of two 16-h.p. and one 9-h.p. nominal Otto gas-engines, and three "Castle" dynamos of corresponding size. No batteries are used. There are 312 lamps installed of 200 c.p., 32 c.p., and 16 c.p. The cost of the generating plant was about £1,300, or £26 per kilowatt. The working cost during last year was as follows:

Gas (2,058,700 cubic feet at 1s. 10d., less 10 per cent. discount)	£169	16	10
Water	15	0	0
Petty stores	8	2	0
Engine repairs	6	17	8
Electric repairs	7	4	3
Wages	82	16	0
8 per cent. interest and sinking fund	104	0	0
Total	£393	16	9

During the year, 50,850 units were supplied to the lamps, and the cost per unit works out at 1·855d., an economic result on which both the contracting firm and the owner may be heartily congratulated. The owner estimates that the electric installation gives him fully 25 per cent. more light whilst using 42,000 cubic feet less gas than in 1889, when his premises were lighted by gas.

Constitutional Club.—Messrs. Verity Bros., the contractors for this and the next two installations, have been good enough to supply particulars referring to the three installations. The generating plant at the Constitutional Club consists of two Armington-Sims engines driving Edison dynamos. No batteries are used. The steam from the boilers is required for lighting and other purposes, so that I am not able to give the working expenses in the list. The installation is given in the list principally to show the load factor. Over 1,000 lamps are installed varying from 32 c.p to 8 c.p.

Arts Club.—The generating plant consists of a 6-h.p. Stockport gas-engine, 5½-kilowatt Electric Construction Corporation dynamo, and a battery of 54 L 23 E.P.S. cells. Cost of plant £520, or £94 per kilowatt. The yearly supply is 10,800 units, and the working cost is as follows:

	£	s.	d.
Gas (873,000 cubic feet at 2s. 9d.)	120	0	0
Petty stores	10	10	0
Repairs	5	0	0
Wages	36	0	0
8 per cent. interest and sinking fund	41	10	0
Total	£213	0	0

or 4·726d. per unit, which is much less than the supply from a central station would cost.

Duke of Fife.—This is also a gas-power installation, the generating plant consisting of a 14 nominal horse-power Otto engine, a

21-kilowatt dynamo, and a battery of 52 K type cells. Cost of plant £850, or £48 per kilowatt. Originally the cells were of the L type, requiring a smaller charging current over a longer period, and it was found that by substituting cells of the K type, which take a larger charging current over a shorter period, 25 per cent. of the gas previously required could be saved, the reason being that the engine now works at a more economical load.

Sir David Salomons.—This is a very complete illustration, and contains a large amount of plant required for engineering and scientific research work. The actual capital outlay and working expenses can therefore not be taken as applying to lighting only. Sir David Salomons has been kind enough to give me, as nearly as he could estimate it, that part of the cost which he considers legitimately chargeable to lighting. He estimates the capital outlay of all lighting plant at £10 per 16-c.p. lamp fixed, of which £3 represents the cost of wiring and fittings. This brings the cost of generating plant to £1,550. The motive power is gas, and three batteries are used. The total supply used is 4,390 units, and the cost is as follows :

Gas (372,300 cubic feet at 3s. 2d.)	£58	15	9
Petty stores	1	12	3
Repairs	3	0	0
Battery renewals*	100	0	0
Wages	44	4	0
8 per cent. interest and sinking fund	124	0	0
Total	£331	12	0

or 18d. per unit.

* The figure given for battery renewals is very high. Sir D. Salomons writes on this point : "Apart from all calculations, I set aside £100 a year for cells, this being a close average over seven years."

Three other installations are given in the table which I need not describe at length, as except in size they do not materially differ from those already mentioned. On looking over the table, you will see that the load factor is the most important item as regards cost per unit. You will also see that, in installations for business purposes, the cost per unit comes out much lower than what is charged by supply companies. On the other hand, the comparison is in favour of the supply company when the light is used for domestic purposes. It must, however, not be forgotten that, when incandescent lamps become cheaper, this difference in cost can be reduced.

APPLICATIONS OF ELECTRICITY TO CHEMISTRY.

Continuing his lectures on this subject at the Royal Institution, Mr. James Swinburne directed the attention of his audience last Saturday afternoon to the subject of tanning by electricity. The ordinary processes of tanning, by which the hide was converted into leather, was so slow that various inventors had endeavoured to accelerate them. The first real improvement took place when mechanical motion was employed for the purpose of obtaining a continually fresh application of the tanning liquor to the surface of the leather. From 1849 and onwards various attempts were made to apply electrical methods to the tanning system, and we had now a process, of which Mr. Lorentz A. Groth was the inventor, which enormously lightened the labours of those employed in tanning. His process was a combination of mechanical motion and electrical treatment, the electrodes, consisting of strips of copper, being placed against the sides of the vat. The lecturer directed attention to a diagram of complete tannage by Groth's system, by which the daily absorption of tannin from the liquor was shown during the period of one month. Mr. Swinburne said he would now turn to another subject—the electrolysis of fused salts, and he hoped to be able to show some experiments on this subject, but he must remind his audience that the laws of Nature did not hold good in the Royal Institution, and his experiments might be interfered with by exterior agents. What did we mean when we spoke of "ordinary temperature"? There are some things which we called solid which in other quarters of the globe were liquid, and, *vice versâ*, things which we knew as liquids were solids elsewhere. We knew, for instance, that the composition of the atmosphere varied in low temperatures. Several experiments were now shown of the electrolysis of fused salts—tin chloride, antimony chloride, sodium chloride, lithium chloride, magnesium chloride, calcium chloride, amongst others, being made subjects for experiments. Speaking of the deposition of aluminium, the lecturer said that many people were of opinion that aluminium could not be deposited by the aid of a separate electric current, but we know now that this opinion was not correct, as various experiments had shown that aluminium could be deposited electrically. Glass was one of the best, if not the best, insulator we possessed, and it could be shown that the electrolysis of glass was quite as easy as the electrolysis of anything else. Ozone can be developed by electrolysis in aqueous solutions of nitric, sulphuric, or phosphoric acids. To show the manufacture of ozone high pressure was required, and also a special plant. The lecturer said he must therefore content himself with explaining the principle of its manufacture. He would take this subject first at his concluding lecture on Saturday next.

Old Paris.—Messrs. Vaughan and Brown are lighting the whole of *Old Paris*, the Bastile, and the grounds with gas and electric *light*.

COMPANIES' MEETINGS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED

The sixth ordinary general meeting took place on Friday last at Winchester House E.C., Sir John Pender (chairman) presiding. The secretary (Mr. E. Cunliffe Owen) having read the notice convening the meeting,

The **Chairman**, before moving the adoption of the report and accounts, drew attention to a misprint which had occurred in the accounts sent out to the shareholders. In the second item in the capital account the addition of the sums expended on buildings down to 1891 and to the end of last year had been made to appear as £127,439, but the total should have been £133,429. The total of the capital account was, however, not affected, and the misprint had no bearing on any other of the published accounts. Coming to examine the accounts, he observed that the capital accounts (Nos. 1 and 3) contained little that was new. They showed that the £50,000 debentures, to which reference was made at the previous meeting, had been issued, and now formed part of the Company's capital, and they were mostly held by the shareholders, a position which was very satisfactory. The capital expenditure during the past year had been mainly confined to the completion of the Amberley-road station at Paddington, with its plant and machinery, and to the extension of the underground mains, which now amounted to about 200 miles, and the provision of transformers and meters required for their constantly-increasing customers. He reminded the shareholders that the construction of the Amberley-road station had not been contemplated in their original estimates, and it was due to the recent inclusion of the Paddington district in their original areas, which had necessitated the debenture issue. With regard to the management expenses, as he had explained on a previous occasion, they had been divided between capital and revenue on what the auditors considered to be a fair principle, having regard to the time which had been required in settling and carrying out the various details of construction, the charge to capital being a decreasing one ; so that when construction was practically completed the revenue would have to bear the whole of those charges, which he had no doubt it would well be able to do. An item which appeared on the accounts for the first time was that under the heading of "expenditure relating to compensation for damage and cost of properties acquired, £3,311." That amount concerned one of the greatest difficulties that they had had to meet in carrying out their works. It had proved to be impossible to lay down large quantities of machinery in thickly-populated districts without provoking a certain number of complaints of vibration which might or might not have been justified, and in some cases, rather than incur litigation, they had been obliged to acquire properties closely abutting on some of their stations. They had never experienced any difficulty in letting such property as they had offered to tenants, and they were now receiving a fair rate of interest on those purchases. Turning to the revenue account (No. 4) the first and most gratifying point was that whilst the income from the sale of current had increased 35 per cent., the cost of production had only risen about 4 per cent. The coal bill was of course the great item of interest, and the Directors were glad to find their anticipations that the consumption of coal would not increase at all proportionately to the income had been so fully verified, and they believed that the improvement in that direction would become still greater as the business increased. They would notice in that account for the first time the introduction of a depreciation fund. As he had mentioned at last year's meeting, the Directors were fully alive to the necessity of providing for wear and tear of the buildings and plant, more especially as regarded accumulators. It must, however, be borne in mind that their buildings were quite new, that their plant was only really now settling down into full working, and that all the money spent in keeping it in the perfect order necessary for successful working had been charged directly to revenue. The Directors therefore considered that they had fairly met the necessity of the case by appropriating the sum of £4,000 to that purpose, leaving the amount to be increased year by year as might seem most desirable and practicable. The Board had commenced a most desirable writing off of the item of preliminary expenses, which had been reduced by the sum of £1,000, and it would be gradually extinguished by future reductions. After makin these appropriations, there remained a balance to credit of net profit of £11,558, and the Directors recommended the distribution of £9,980 as dividend at the rate of 4s. per share, leaving a final balance to commence the net revenue account of 1893 of £1,578. He drew particular attention to the sixth paragraph in the report, and in which they referred to the fulfilment of the anticipations more than once expressed as to the decrease of working expenses in proportion to the increase of business. They regarded that feature as a proof of the ultimate prosperity of the Company, and the more they could employ their plant the more economically they could supply current. The main difficnlty at present lay in the character of their supply to the residential portion of their area. As a rule, private consumers did not benefit them to the same extent as commercial customers, and that required some explanation. It would surprise many of them to learn the varying requirements of householders ; some considered that 10 lamps would be sufficient, others required many hundreds, and it was not always the largest house that contained the greatest number of efficient lamps. The effect of that upon their supply was not altogether satisfactory. The small consumer who used all his lamps regularly was a far better customer for the Company than the large householder whose normal consumption bore an extremely small proportion to his maximum requirements. The latter would two or three times a year turn on all his lamps, and their machinery had to be prepared to meet that emergency, which might arrive at any time. They were therefore obliged to keep a certain portion of their machinery in reserve which under other conditions might be more profitably employed. That matter had become of such importance that he thought that they would apply to the Board of Trade to get it rectified. In order to emphasise his remarks concerning the varying yield per lamp per annum from different consumers, he mentioned that restaurants and other establishments where business was carried on during long hours yielded as much as 30s. a lamp yearly, whereas many private consumers only averaged about 2s., or even less, and in one or two extreme cases the return was only 4d. per lamp installed. In order to meet those fluctuations and to benefit their good customers, they had recently adopted a sliding scale system, which experience had shown was well adapted for the purpose. He had no doubt that the time was not far distant when an effort would have to be made to obtain a minimum return for each lamp connected to their mains. It must be understood that the Company did not keep their plant entirely idle to cope with possible maximum demands, which could never all arise at one and the same time. They had, therefore, the power of allowing an ample margin for taking on additional lamps without any perceptible increase of working expenses, with the exception of a small quantity of additional coal, having in any case to be incurred. Experience was now teaching them how far they could safely increase their lamp connection beyond the number which their machinery was calculated to supply at one time, and in the light of that experience they were able with confidence to fill up their area more closely than was originally anticipated would have been possible with the present plant. Coming to consider the number of lamps connected, he drew attention to a wall diagram, which showed that the number at the end of 1889 was 10,600; 1890, 48,000; 1891, 82,000; and at the close of last year, 124,000, whilst down to the middle of April of this year the quantity had been increased to 135,274 lamps. Those figures showed how regularly the increase had grown, and from the applications now in hand, they had every hope that that steady demand would be maintained. With regard to street-lighting, to which he referred at the previous meeting, that was still in abeyance, but it was possible that the local authorities might call upon them to undertake the work. They did, however, not intend to enter into any contract for that purpose except on fairly remunerative terms. The complaints which had arisen at one of their stations of vibration was giving them great cause for anxiety, but as an action was pending he was unable to say much on the matter. He would, however, mention that their engineer, acting in conjunction with the best expert advice, had devised a plan for putting an end to all possible ground of complaint, and they were sanguine that the results of the works in progress would prove successful. In order to meet the payment due on account of the Paddington station, which had recently been started, and to provide for the mains laid up to the end of the year, it had been necessary to incur liabilities in excess of their present capital; and they had further expenditure to provide for the mains which had yet to be laid. It was therefore necessary for them to issue the remaining £50,000 debentures, and a circular on the subject would shortly be sent out to the shareholders. He doubted whether there was any better security to be found in London than the debentures of that Company. As he had already mentioned. they had provided for a very large increase in the consumption of light, and, therefore, whilst they were not now paying a large dividend, they were laying the foundations for paying a much larger one in the future. When the formation of the Company was originally contemplated, the Directors felt that electricity as a motive power was likely to be largely used, and they still believed that would take place. He had recently seen Mr. Crompton's apparatus for cooking by electricity, and he opined that that would eventually take a very great hold not only in large but also in small houses With their extended area he thought they were likely to use their current for working purposes, especially as cooking would be done during the day, whilst the light for illuminating purposes would be most generally used at night. Considering the progress now being made in electricity, he had no doubt that if the shareholders retained their holding, they would find that they had one of the safest, encouraging, and steadily increasing investments existing in London. He had received a letter from a customer who said that he estimated that electricity cost 25 per cent. more than gas, and the speaker thought that if the current could be produced on a large scale, and at only 25 per cent. more than gas, many people would try it. The Board had been strengthened by Sir Eyre Shaw taking a seat. After referring to the former connection with the Company in its early stages of Mr. J. Spencer Balfour and others, he moved the adoption of the report and accounts and the declaration of a dividend at the rate of 4s. per share.

Sir George Elliot, Bart , seconded the motion.

After a brief discussion, the motion, on being put, was unanimously adopted.

The retiring directors, Sir John Pender, Sir James Anderson, and Sir George Elliot were re-elected, and Messrs. Deloitte, Dever, Griffiths, and Co. were re-appointed auditors.

Votes of thanks to the Chairman and Directors brought the proceedings to a close.

London-Platino Brazilian Telegraph.—The Board recommend, after placing £1,182 to reserve, a dividend of 4s. per share for the year 1892.

BUSINESS NOTES.

Oxford-street.—Messrs. Wm. Ramsay and Co., Argyll-street, have just finished a large electric lighting installation in Oxford-street West, London.

Dorchester.—We see it stated that arrangements are being made to light the town of Dorchester with electricity. Mr. Dale, C.E., electrical engineer, of Sherborne, is the promoter.

Chatham.—The electric light is becoming very popular in Chatham. Messrs. H. A. Couchman and Co. have a fine installation—the first to be supplied from the new underground mains.

Madras Electric Tramways.—Mr. S. A. Chalk, managing director of the Madras Electric Tramway Company, who will reside at Madras, arrived at that city from England on 26th ult.

London Branch.—Messrs. Winfields, Limited, of Birmingham, have appointed Mr. Seymour Cromen, late manager to Messrs. F. W. Reynolds and Co., of Southwark, to the charge of their London business from May 1.

Greenock Yachting.—Mr. Thomas Orr, junior, boatbuilder, Greenock, has just completed a 50ft. steam yacht, which has been purchased by Mr. Clark, Kilmarnock. The yacht will be handsomely fitted up and lighted with electricity.

Earl's Court Exhibition.—Messrs. Johnson and Phillips have contracted for the supply of upwards of 200 Brockie-Pell arc lamps for the electric lighting of the buildings and grounds of the Gardening and Forestry Exhibition to be opened at Earl's Court next month.

Personal.—Mr. Arthur Bergtheil, of Messrs. Bergtheil and Young, sailed for the United States and Chicago by the ss. "Germanic," which left Liverpool recently. Mr. Herbert Laws Webb is in England for a short time, but is expecting to return to the States shortly.

City Business.—Mr. Todman, amongst other work, has fitted installations for the following: Henry S. King and Co., Cornhill; Lloyd's Bank, Lombard-street; Messrs. Daw and Co , new premises, Monkwell-street, complete installation and plant; Dombey and Son, Cannon-street, and others.

City and South London Railway Company.—The receipts for the week ending April 23 were £851, against £807 for the corresponding period of last year, or an increase of £44. The total receipts for 1893 show an increase of £1,266 over those for the corresponding period of 1892.

Bombay.—Khan Bahadur M. C. Murzban, C.I.E., executive engineer of the Bombay Municipality, has submitted to the Municipal Commissioner a proposal by which both the Crawford Markets and the municipal offices can be lighted with electricity at the cost at which the Crawford Markets are now lighted with gas.

Change of Address.—The National Telephone Company, Limited, notify that, on and after May 1 next, their offices, so far as regards their metropolitan business, will be transferred from Oxford-court, Cannon-street, to 58 and 59, London-wall, E C. The head offices for secretarial and provincial business will remain, as heretofore, at Oxford-court.

Hove.—Local investors are being invited to take shares in the Hove Electric Lighting Company, Limited. Almost from the starting of the lighting station the earnings from the supply of light have been in excess of the expenditure, and each week the amount has steadily risen. Such a prosperous position foreshadows a bright future for the company.

Western and Brazilian Telegraph Company.—The Directors recommend a balance dividend of 4s. 6d. per share, making a total distribution of 2½ per cent. for the year 1892. The reserve fund has been increased by £15,000, leaving £2,829 undivided. The traffic receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,937.

Huddersfield.—The Huddersfield Electric Lighting Committee are prepared to receive tenders for the wiring of and for the supply of electric light fittings for the electric supply station. Plans and specifications may be obtained upon application to Mr. A. B. Mountain, borough electrical engineer, Gasworks-street, Huddersfield. Sealed tenders to be addressed and sent to the borough electrical engineer not later than Tuesday, the 9th day of May, 1893.

Lighting in Glasgow.—The steel and iron works of Messrs. David Colville and Sons, Motherwell, Glasgow, have recently been lighted throughout by Messrs. R. D. Smellie and Co., of Glasgow, by means of arc lamps instead of oil lights of the Lucigen type by which their works had formerly been lighted. Other large works in which electric light installations have been adopted are those of the Clydebridge Steel Company, the iron and ammonia works at Shotts, Coltness, Calder, and Govan, and the city saw-mills of Dixon, Limited, Glasgow. These have been erected by the same firm, who are evidently doing a large amount of private installation work in the district.

Removal.—Messrs. J. D. F. Andrews and Co. have removed their offices from 41, Parliament-street to their works, 15, Marsham-street, Westminster, where the business will be carried on, as before, under the personal direction of Mr. J. D. F. Andrews. Extensions and arrangements have been made to facilitate the manufacture of the appliances, materials, plain and artistic fittings of Andrews's concentric wiring, and of arc lamps, transformers, etc., as well as the system of mechanical ventilation by induced air currents successfully introduced in the New Law Courts and many large steamships. The new firm do not undertake any of the liabilities of the late partnership. Prior accounts will be paid by C. Comins, 46, Cannon-street, London, E.C.

West Coast of America Telegraph.—The gross income for the year 1892 was £22,218. 16s. 9d., against £35,624. 16s. 5d. in 1891, and in order to continue meeting the debenture coupons with regularity, it was necessary this year to take £10,287. 8s. 2d. from the reserve. The receipts include the sum of £4,782. 13s. 6d. from the Chilian Government in settlement of the Company's claim for damage to the cables during the revolution in 1891. The total expenses were £21,919. 14s. 8d., against £24,406. 19s 7d. in 1891. A concession has been obtained from the Chilian Government for an extension of the Company's cable to Talcahuano, with a land line to the city of Concepcion.

Islington.—The Highways Committee of the London County Council state that they reported on 21st February last that three applications had been made for provisional orders with regard to the parish of Islington, one by the Vestry and the other two by companies; and that they had suggested to the Board of Trade that preference should be given to that of the Vestry. The Board has since intimated that the applications of the two companies will not be proceeded with; and has forwarded a copy of the order in the form in which the Board proposes to issue it to the Vestry. The principal amendments suggested on behalf of the Council having been made in the order, they consider it to be satisfactory.

Canterbury.—The terms of the arrangement under which the Canterbury Town Council propose to hand over their electric lighting order to the Canterbury Electricity Supply Company, Limited, have now been settled and the document duly signed, sealed, and delivered. The company repay the Council the costs they have been put to in obtaining the order, and take upon themselves the entire responsibility and risks of the installation. The city is, we believe, in no wise pledged to make use of the new illuminant, but the company are required to be prepared, within a period of two years from April 14, 1893, with supplies available for possible customers throughout the greater part of the city. Powers of purchase, under certain conditions, are also given to the city authority. It now only remains to obtain the approval of the Board of Trade to the scheme.

Huddersfield.—At the last meeting of the Huddersfield Town Council it was reported that the tenders of the Electrical Construction Corporation, of Wolverhampton, for the supply of main switches and fuses, and of the W. T. Henley Company for the supply of cables, had been accepted, and that the electrical engineer had been instructed to proceed with the procuring of another 200-unit plant. In reply to a question, Councillor Garton stated that the applications already received for installations of the electric light were more numerous than could be complied with, with their present machinery, during the coming winter. They had been obliged, therefore, to increase their machinery by one third, and this, they believed, would be ample for the requirements. The Council expressed satisfaction with this answer, and the minutes of the committee were confirmed.

Cardiff.—A meeting of the Cardiff Electrical and Lighting Committee was held in the Town Hall last Friday, when there were present: the Mayor (Mr. W. E. Vaughan), in the chair; Aldermen Jacobs and P. Carey, and Councillors W. Evans, Trounce, Gerhold, J. H. Cory, Jenkins, Short, Munn, and Andrews, with the borough engineer (Mr. W. Harpur). The meeting had been convened for the election of a lighting inspector, and the testimonials of the several candidates having been read, the committee, after careful consideration, appointed Mr. Charles Irwin, of Cathays. The Mayor announced that the work in connection with the electric lighting works had been started, and that tenders for the works would be out by the next meeting. He suggested that a clerk of the works be at once appointed to superintend. Alderman Jacobs proposed this, and it was agreed to unanimously.

Brazilian Submarine Telegraph Company, Limited.—The report for the half-year ended December 31 states that the revenue amounted to £113,891, and the working expenses to £24,536. After providing for debenture interest, sinking funds, and income tax, there remains a balance of £74,927; to this is added £3,073 brought forward. First and second interim dividends, amounting to £39,000, have been paid, and £35,000 transferred to the reserve fund, leaving £4,000 to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30, 1892, on the Company's shares in the African Direct Telegraph Company, Limited. In accordance with the provisions for repayment of the first issue of debentures, dated July 31, 1884, 177 bonds, representing £17,700, were drawn on the 17th inst. for payment at par on July 31 next. This, with the previous drawings, will make a total repayment of £131,300, leaving £18,700 of the first issue of debentures outstanding.

City Lighting.—The City of London Electric Lighting Company give notice that, unless unforeseen circumstances arise, electric energy will be laid on within the next few months in the following areas: (1) Fetter-lane sub-area, bounded by High Holborn, St. Andrew's-street, Shoe-lane, Fleet-street, and western City boundary; (2) St. Andrew's-hill sub-area, bounded by Ludgate-hill, St. Paul's-churchyard, Godliman-street, St. Paul's Wharf, River Thames, and New Bridge-street; (3) Warwick-square sub-area, bounded by Newgate-street, St. Paul's-churchyard, Ludgate-hill, and Old Bailey; (4) Crosby-square sub-area, bounded by Old Broad-street, Wormwood-street, Houndsditch, St. Mary-axe, and Leadenhall-street; (5) Bartholomew-close sub-area, bounded by northern City boundary, Aldersgate-street, St. Martin's-le-Grand, Newgate-street, and Holborn-viaduct; and (6) Falcon-square sub-area, bounded by Jewin-street, Fore-street, Aldermanbury, Gresham-street, and Aldersgate-street. Consumers will be connected up in the order of application, provided they are ready to receive *current when the* company is ready to supply. To enable the *company to make timely provision, all* applications should be sent in as early as possible. Forms of application and all particulars can be obtained at the office, 1 and 2, Great Winchester-street.

Killarney.—A company has been formed under the title of the Killarney Electric Light Company by Mr. C. E. Leahy, who has obtained a provisional order for the lighting of Killarney. Instead of giving the contract for the supply and erection of the plant to a contractor, as in the usual way, the company have appointed Mr. Victor A. H. McCowen as their engineer, to prepare plans and specifications Contracts have been placed with different firms for the machinery, mains, pipes, etc. The erection of the plant, laying of mains and installing is being carried out under the supervision of the company's engineer. Since the provisional order was applied for the price of gas has been reduced 25 per cent.—*i e.*, from 7s. 6d. per 1,000 cubic feet to 5s. 9d. per 1,900 cubic feet, which is the present price. The maximum price for current will be 6d. per B.T.U., and as the company have very fine water power, they expect to be able to compete successfully with the gas. The Killarney people were treated to a display of the lights last week in the company's office, where they were also shown that the current could be used for cooking purposes and cigar-lighting. All appeared to be greatly pleased with the brilliancy and steadiness of the light, and orders are coming in for hotels, shops, and private houses. The company deserve to be encouraged in their project: they did not expect an order before the lights were shown. An advantage to the town is also the way in which they have caused a reduction in the price of gas.

Bournemouth.—At the meeting of the Bournemouth Town Council last week, the Lighting Committee reported the receipt of a letter from the Local Government Board, enquiring whether the Town Council intended themselves to generate or manufacture electricity, and stating, if that be the case, they may not generate or manufacture electricity unless they have obtained power to do so by provisional order under the Electric Lighting Acts. The committee recommended that the town clerk be instructed to take the necessary steps to obtain the grant of a license, and that application be made to the Local Government Board for sanction to borrow the cost of the works necessary for distributing electricity pending the grant of the license. The committee also reported that they had instructed the town clerk to enquire whether and upon what terms the Bournemouth and District Electric Light Company would supply electricity for lighting their pier and pleasure grounds, the Corporation providing the lamps and means of distribution. In reply to a question, the Surveyor stated that the estimated cost of the works for distributing the electricity for pier and gardens was £3,200. In reply to Councillor Webber, the Town Clerk said he did not anticipate that their application for a license would be opposed by the electric light company. The light was only intended for the use of the Council. Even if there were opposition the cost would not be very great. Replying to Councillor Lawson, the Town Clerk said the cost of a license would probably be from £50 to £100. It would be five or six months before a license could be granted. The report was adopted.

Electrical Cranes.—The Southampton Harbour Board have recently ordered two electrical cranes to be placed on the town quay there, and the contractors for the work are Messrs. J. G. Statter and Co., of Westminster, electricians, who have entrusted the greater portion of the undertaking to Messrs. Stothert and Pitt, Limited, the well-known engineers and ironfounders, of Bath. They carry a maximum load of three tons, and are so constructed that they can be moved along the quay to any point required. They are worked by two separate electric motors, the requisite current being supplied from the town mains. The load is lifted by one motor while the other revolves the machine, both being worked by worm and wheel gearing. There is a special arrangement for stopping the mechanism in case of any interruption with the electrical current. The power is transmitted to the snatch-block pulley through a patent electrical transmitter, manufactured by a Bristol firm, and the load is lifted by steel wire rope. Last week the cranes were tested on the premises of Messrs. Stothert and Pitt, in the Lower Bristol-road, in the presence of the Mayor of Bath, the Mayor of Southampton (Mr. Lemon), and a number of members of the Southampton Harbour Board. The test proved very satisfactory, and the Mayor of Southampton expressed the pleasure it had afforded the deputation and himself to visit the works, which he spoke of in complimentary terms. Messrs. Statter and Pitt thanked Mr. Lemon for his kind remarks, and said they had endeavoured to put into the machines the best work possible. Subsequently another crane in the yard, similar to the huge block-setting Titan, recently manufactured by Messrs. Stothert and Pitt, Limited, was satisfactorily tested, the maximum load carried by this being 30 tons.

Scarborough.—There are signs, says the *Scarborough Post*, that the Scarborough Electric Lighting Company are getting energetically to work. The laying of the pipes for the company's mains was commenced on Friday last, three gangs of men of 10 each getting to work, one at the works' end, one in the Valley, and one by the station and through the drive into the Valley. The pipes at the Seamer-road end are of 6in. diameter, and owing to an awkward curve they are occupying more time to lay than was at first thought would be the case. Fair progress has, however, been made; and of the whole length to the corner of Westborough about one-fifth is complete, it being hoped to finish the remainder of this portion by about the middle of next week. As each section of pipe from junction-box to junction-box is laid, a plain galvanised-iron wire is laid through. This has been the cause of considerable comment, many people, supposing it was the supply cable, asking if it was not dangerous to lay an uninsulated wire in metal pipes! A rope will be drawn through the sections by the aid of this wire, and the cables in half-mile lengths will then be threaded through, another wire accompanying, so that the succeeding cables may be threaded. Up to a point in the Valley four cables will be placed in the pipes—two lead and two return--but there will be room for 12. The transformer-boxes will be let flush into the pavement, the pipes being jointed to them with indiarubber washers. The covers will be screwed on, an indiarubber joint preventing the entry of the wet. Meanwhile, while the mains are being pushed on with all possible speed, capital progress is being made with the works In about another month the roof will be on; the boilers are to be delivered this week, and the engines have already been tested so that the dynamos and engines can be set up almost immediately after. A large area of the reservoir has been dug out—in fact, capital progress has been made. The contract, it may be mentioned incidentally, has been given out for lighting St. James's Church by electricity.

London Mains.—The Highways Committee of the London County Council have considered a notice, dated March 28th, 1893, from the St. James's and Pall Mall Electric Light Company of intention to lay mains, consisting of armoured cables laid in the ground, or of insulated cables drawn into bitumen cases or iron tubes, in the following streets: Air-street, Archer-street, Argyle-place, Arundel-street, Beak-street, Bentinck-street, Berwick-street, Bridle-lane, Boyle-street, Brewer-street, Canton-street, Clifford-street, Cork-street, Denman-street, Edward-street, Fouberts-place, Great Windmill-street, Glasshouse-street, Green's-court, Heddon street and court, Hill's-place, Hopkins-street, Husband-street, Ingestre-court, Kemp's-court, King-street, Leicester-street, Lexington-street, Lower James-street, Lower John street, Little Marlborough-street, Little Pulteney-street, Lownes-court, Marlborough-court, mews, and row, Marshall-street, New and Old Burlington streets, New-street, Noel-street, Peter-street, Portland-street, Pulteney-street, Ramillies-street, Regent-place, Rupert-street, Savile-row, Sherwood-street, Tyler street and court, Upper James-street, Upper John-street, Upper Rupert-street, Vigo-street, Vine-street, Walker's-court, Wardour-street, Warwick-street, and West-street. They recommend that the sanction of the Council be given to the works referred to upon condition that the company give two days' notice to the Council's chief engineer before commencing the works; that the covers of the street-boxes to be used be supported on 3in. York stone; and that before any street boxes are constructed the designs for and the proposed positions of them shall be submitted to and approved by the Council's chief engineer. The committee have also considered a notice dated April 18, 1893, from the House-to-House Electric Light Supply Company, of intention to lay mains in Philbeach-gardens. The proposed works are unobjectionable, and they recommend that the sanction of the Council be given to the works referred to upon condition that the company give two days' notice to the Council's chief engineer before commencing the work; that no pipes of a larger diameter than 6in. shall be used; that the street boxes shall be of the pattern approved by the Council; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth.

Water Power in Scotland.—The *Glasgow Herald* is publishing a series of articles on "Electricity as an Illuminant." In the fourth article the writer thus refers to the utilisation of water power in Scotland: "Of late, especially, much attention has been directed to another source of mechanical energy for purposes of electric lighting—we refer to falling water. This natural source of power has been used by the civilised nations of the past for very many centuries, and it is still used in this country though only to a comparatively minute extent, notwithstanding the modern steam and other engines. Though water power, owing to some extent to its scarcity or inaccessibility and to the cheapness of coal where power is most needed, is so little used, yet the case is very different in other countries. It is computed that in the whole of the United States of America 36 per cent. of the power used in manufacturing is water power. It is also estimated that the available water power from falls in Switzerland is equal to 582,000 h.p., of which 80,000 h.p. is, it is believed, utilised. An exceedingly interesting scheme of this nature for the lighting of Rome by electricity transmitted from a distance, was successfully carried out nine months ago. The water power is obtained from the falls of the River Arno at Tivoli, 17 miles from Rome. Conveyed from the falls along an old Roman aqueduct, the water passes into a great wrought-iron pipe, 160ft. high and fully 5ft. in diameter, which is kept full by the water. This great vertical pressure, or head of water, is transmitted to a station near by where it branches into three channels, each feeding three turbines driving dynamos. The electric energy thus produced at the dynamos at Tivoli is equivalent to 2,700 h.p., and it is transmitted by four cables along the 17 miles of intervening space to Rome at a pressure of 5,100 volts and a current of 42 amperes. The insulated cables contain altogether 100 tons of copper, and 20 per cent. of the electric energy at the dynamos at Tivoli is lost on the way to Rome. All the data here given are believed to be official, yet in many well-informed quarters it is believed that the question of the utilisation of power from waterfalls, for reasons partly referred to in this article, is not likely to receive much further practical development in Scotland, and the efficiency claimed for it abroad in many places is to be doubted." This opinion is not very encouraging to electrical engineers in Scotland: we should think on the contrary that in Scotland, as in Switzerland, a large development of the utilisation of water power will come. It is true that there coal is cheap, while it is dear in Switzerland and Italy, but the progress of systems for transmitting power will surely lead, we should fancy, to the practical developments desired.

Edinburgh.—A meeting of Edinburgh Town Council was held last Friday, for the special purpose of considering the report by the Lord Provost's Committee, recommending that the Magistrates and Council retain the electric light undertaking in their own hands. A deputation was received, and Mr. F. T. Cooper, advocate, read a petition against the proposal. He urged that the city should not incur a debt of £100,000; that electric lighting was in the "experimental stage." He hoped the lighting would be taken up by a company—any company. The deputation having withdrawn, the Lord Provost Russell moved the adoption of the report. In looking at the history of the question in Edinburgh he pointed to the experience which in the early eighties they in Edinburgh, had had of an installation in Princes-street. That was not quite a success, partly owing to the fact that the matter was very new, that the work was not carried out as it would be done nowadays, and that the requirements of the public and of the Board of Trade were not so severe as they were now. He thought the history of the past should show them that they ought to keep this undertaking in their own hands. It had been said that electricity was still in an experimental stage, but he took it that the experimental stage lasted until they could show that it was able to pay. They could show a long list of companies and of towns that were able to make electric lighting pay. Therefore the experimental stage, so far as they were concerned, and as far as any serious risk of loss was concerned, was past; but the experimental stage in which improvements were still possible existed. If they handed over the work to a company every improvement would be adopted by them, and they should at some future time have to buy over these improvements at a fancy price. The history of their acquisition of the gas and water, and the negotiations in regard to the tramways presented the same difficulties. He asked the Council to follow the example of the Corporations of Glasgow, Aberdeen, Dundee, and other Scotch towns, and take the works into their own hands. Mr. Mitchell Morrison seconded. Though in favour of a company taking the lighting, he was bound to say that the arguments in favour of the city taking up the undertaking outweighed those on the other side. Bailie Walcot moved an amendment to recommit the subject, with instructions to endeavour to lease the work of electric lighting on such terms and conditions as would warrant the Corporation, as acting for the public at large, in accepting it. He pointed out that the control of the drainage, the water, and the gas were three things in which every inhabitant was interested. They were purely citizen work, and affected all in the city. But that was not the case with the electric light. It was a luxury that would be available only for those who were able to afford it. Mr. Colston seconded the amendment. Mr. Kinloch-Anderson said he had given notice of a motion to hand over the electric lighting to the Gas Commission, but after hearing his Lordship's remarks he withdrew the notice of motion and supported the motion. But he wished to point out that when the Gas Commission was formed there was virtually a partnership entered into between the Corporations of Edinburgh and Leith, and that he regarded this proposal as a violation of the partnership. After further discussion the Lord Provost's motion that the Corporation should take the lighting in their own hands was carried by 20 votes to 10. We congratulate the Corporation on the result.

Bristol.—The Bristol Electrical Committee in their report presented to the Town Council meeting last week stated that in the original estimate of £66,000 for the installation of the electric light, nothing was allowed for the purchase and preparation of the site of the central station—only £5,000 for buildings and alterations. The committee, however, found the soil so treacherous that a large sum had to be expended on the preparation of the site (which is Corporation property), and in addition the committee had erected larger and therefore more costly buildings than were at first intended, so that instead of £66,000 being the cost of the installation it would be £83,000. Arrangements had already been made to borrow £50,000 from the Leeds Corporation and £16,000 of the trustees of the Bristol General Hospital, both sums at 3½ per cent., and both repayable in a quarter of a century. Councillor Charles Wills moved the adoption of that portion of the report recommending that £50,000 be borrowed from the Leeds Corporation, and £16,000 from the trustees of the Bristol General Hospital, both amounts at 3½ per cent. He felt that the Council would not fail to confirm the resolution. They would see that the money would be repayable in 25 years. Alderman Sir George Edwards seconded the resolution. Councillor Gilmore Barnett said before that was put he should like to know whether the money could not be obtained at less than 3½ per cent., and why it should be raised by loan instead of the issue of stock? He noticed that the Somerset County Council the other day obtained all the money required at 3 per cent. Insignificant places like Reading and Rhyl seemed to be able to borrow at less interest than the great city of Bristol. Alderman Sir George Edwards asked whether, under the circumstances named, the amount borrowed was to be repaid in 25 years. Councillor Barnett replied that Government would not allow a loan or stock to be negotiated on the part of the city—a sinking fund had to be provided. He did not move any amendment, but he thought it was extraordinary that Bristol, with all its advantages, had to borrow money at a higher rate than other places. He thought that the Finance Committee ought to take the matter into consideration, because a great saving might be effected. The city required a large amount of money, and would require soon at least a million sterling. If this were offered to public competition, he believed that the terms obtained would be very much better than now secured. He trusted that the matter would have the serious attention of the Finance Committee. Alderman Sir George Edwards asked whether the towns Mr. Barnett had mentioned as getting their money at a cheaper rate paid the interest as they proposed to do. Councillor Barnett said he could not say whether those towns would pay their interest half-yearly, but he argued that this had nothing to do with the matter. Alderman Sir George Edwards pointed out that it did make a great difference, as people would not lend money at the same rates unless paid as they proposed. Councillor Barnett said if Birmingham wanted to borrow £66,000 for civic purposes they would issue stock by way of raising it, whereas if Bristol wanted a similar sum they borrowed it on loan at a higher rate of interest. Councillor Twiggs remarked that he was not satisfied that the citizens were wise under the present condition of things, with money getting cheaper, in borrowing at so high a rate as 3½ per cent. He presumed, however, that the committee could not obtain the money upon better terms, otherwise they would not recommend the Council to accept their recommendation. The motion was then adopted. Councillor Charles Wills said that since the report had been placed in his hands he had seen Mr. Preece, and he was led to believe that he would be able to place before them more advantageous figures, and he asked permission therefore, to withdraw that part of the report until the next meeting.

Light and Power at Manchester.—A correspondent signing himself "Motor," criticises the Manchester Corporation electric lighting scheme in the *Manchester Guardian*. He complains "that the scheme is not being worked on business principles. Instead of adopting cheap fuel gas as a means of producing the power requisite for generating electricity, they have erected an ugly, costly, and quite unnecessary chimney, and are going to use steam, which will cost them twice as much per horse-power as gas. Then, by way of stimulating consumption, they have managed to so be-fog and bewilder the ordinary city tradesman that not one man in 50 has the remotest idea how much the light will cost him if he adopts it. A mixed arrangement of charge by meter and rental per lamp has been devised, which is needlessly complicated and ought to be abrogated. The price should be reckoned either one way or the other. In one of the Lancashire watering-places—Morecambe—the price to all shopkeepers is £1 a year per lamp; and to private houses 6d. per Board of Trade unit. The result is that the demand has from the very beginning been ahead of the supply, and the directors are just now busy doubling their plant, having hundreds of unsatisfied applicants down in their books. 'Even the fried fish and tripe shops have got it,' I am informed. But in Manchester everyone seems afraid of venturing, for no one can tell exactly what it will cost, and that in a place of business is a fatal objection. There is, however, one most important field which our conscript fathers seem inclined completely to ignore, and that is the use of electricity for motive power. To ensure the economical working of a central supply station it is indispensable that the load upon the engines and generating plant should be as equable as possible. In this important point the electric lighting engineer works at a great disadvantage as compared with his fellows in other departments. On a foggy day, and during the evening hours, everyone wants the light, while during the day scarcely anyone requires it. But the engineer must be ready for the maximum demand, which in some seasons may come upon him suddenly and unexpectedly. Consequently, tens of thousands of pounds' worth of plant lie idle all day long, in order to be prepared for a very heavy strain, lasting two or three hours only. How is he remuneratively to employ all this idle plant? By the supply of motive power. His machinery is ready; the boilers are heated, the fires all burning, ratepayers' money is flying up the ugly chimney; everything urges to action, and yet our town hall people propose to do nothing, or at least they propose to charge as high a price for current used in the daytime for motive purposes as for what is consumed during the precious hours of darkness. This is wisdom with a vengeance! Every pound earned in the daytime helps to reduce the all-round cost, and it is far more profitable to sell power during certain hours at half-price than to have the machinery lying idle, with banked fires smouldering away and capital earning no return. At Norwich the authorities have awakened to this fact, and are charging only half-price in the daytime. In Bradford the price is 5d. per unit, and in other places similar concessions are made to those who help to provide what is called a 'day load' for the engines. In America fan motors for ventilating offices are as common as fireproof safes. There are scores of purposes to which this subtle and pliant force can be turned, such as the working of warehouse hoists, turning lathes, rolling and folding machinery, mincing and chopping machines, sewing machines, laundry machinery, churns, and pumps; and may be made to work organ bellows, dentists' drills, church bells, barber's hair-brushes, and a host of similar utensils at present operated by hand. Then electricity can be used for domestic cookery and for heating flat-irons. Indeed, its uses are legion, and a wise spirit of economy should lead the electrical authorities of our city to do all in their power to encourage business people to avail themselves of the silent and docile energy which will soon be passing under their very feet." In conclusion, he trusts that a large number of people *will make application* to the Town Hall at once for a supply of *the electric current for purposes such as* the above, but attaching to their application a condition that the charge shall not exceed 5d. per unit, at which price a motor can compete favourably, as regards economy, with a gas-engine for many descriptions of work.

Folkestone.—At the Corporation meeting last week there was a notice on the agenda "To consider the expediency of introducing the electric light into Folkestone, either generally or over a limited area of the town, and as to terms and arrangements, and generally in relation thereto." Councillor Thompson introduced the matter. He took it for granted that they all believed in electric light as a light, and that it would be an attraction to the town. When they last discussed the question, the lowest price, if he remembered rightly, that was to be charged for private lighting was 1s. per Board of Trade unit, and, secondly, the cost for arc lights was £22. 10s. per arc. So rapid had been the improvement in electrical apparatus and the management of it that at the present day the 1s. was brought down to 3½d. per Board of Trade unit, and the price of the arc light was reduced to £12. 10s. Then as to the paying power, and the possibility of the light paying for itself, that must be judged by the circumstances he would place before them. He would take two or three places where it had been introduced under disadvantageous circumstances, but where they had been overcome, and they had been able to show a profit when there was formerly a loss. He took first Bradford, where in 1889, there was a loss of £1,078; 1890, of £1,038; but in 1891 they made a net profit of £948, and 1892 a net profit of £1,476, so that they had not only recouped their loss, but showed a profit of £300 in four years. At the present moment the price per unit was 6d. At St. Pancras for the year they made a net profit balance of £1,008. although the expenditure extended over a period of considerably more than a year. He gave some further figures with regard to St. Pancras, and then turned to Brighton, where the Corporation had expended £37,000 in the works. The report for 1891 said that the works were opened on September 5. Their price was 7d. per unit, but now reduced. They showed a gross profit of £250 for the period from September 15 (11 weeks). The works started with four customers only, but gradually increased during the quarter to 82, with 2,374 lamps, whilst they had power to supply 10,000. At the last Lighting Committee it was reported that there were 10,248 8-c.p. lamps, and the success was far greater than was anticipated. The revenue resulted in a net profit of £108 for the year 1892, after paying interest and redemption fund. That would give them sufficient practical information to enable them to come to a conclusion that it was desirable to consider the introduction of electric light into Folkestone. Then as to the charge. It ranged from 8d. down to 3½d. per Board of Trade unit. In towns like Folkestone he came to the conclusion that they could introduce it for, at the outside, 5d. per unit, and they would find that, taking all things into consideration, would not exceed the price of gas at the present moment. He then dealt with the subject of arc lighting, and gave particulars gained from the returns of St. Pancras, where he said some very interesting experiments had been made to test the value of electric light as against gas, by having the two sets of lamps alight alternately, and the contrast was said to have exceeded their most sanguine expectations. He was going to move that a committee be appointed to consider the matter and prepare a scheme, and with power to employ the services of an electric expert. He named the Deputy Mayor, and Messrs. Tolputt, Vaughan, Pursey, Logan, Spurgeon, and himself. He said he had not named the Mayor, not because he objected to the Mayor, but in deference to outside people, who might make invidious remarks on the fact that he was a director of the gas company. But he had noticed that every time the Mayor had occupied that seat he had taken no undue advantage of it to do anything to benefit any company with which he might happen to be connected. The Town Clerk said if the Mayor elected to sit as chairman he could do so. Councillor Pursey seconded the motion. He said he thought the time had arrived when they ought to make a thorough enquiry into that subject, considering that various watering-places were installing electric light and that during the next few months they would see it at Dover and Canterbury. Alderman Pledge thought they should wait till they saw what was the result at Dover and Canterbury. Electric light was still in its infancy. (Councillor Thompson: Oh, lord, no). According to Mr. Thompson's own showing, if they had carried out the electric lighting two or three years ago, when he tried to introduce it, they would have been mulcted in a very large expenditure. He contended that it would be wise to wait some time longer before they committed themselves to anything. After a little more discussion, the motion was carried. The question of employing an electrical engineer was referred to, and it was understood that the maximum limit of expense the committee should incur, should be 50 guineas. The Mayor said he was going to rule that on all occasions when the electric light was discussed, they could all vote whether they were gas shareholders or not.

Bradford Central Station.—The *Leeds Mercury* has the following article on the Bradford electric lighting, which it cites as an instance of a profitable undertaking: "Judging from experience in Bradford, electricity is becoming more and more popular as a means of lighting. Bradford was the first municipal body in this country to attempt the supply of electric light, and its experiment has been watched with interest from all parts of the United Kingdom. The Bradford Corporation is fortunate in having as chairman of its Gas and Electricity Committee Alderman Frederick Priestman, a gentleman with a keen appreciation of the possibilities and probabilities of the future. The Bradford Corporation Electricity Works were opened in September of the year 1889, and at that time they comprised three Lancashire boilers of 180 h.p.; each were coupled to dynamos of 150 i.h.p. From the first, however, the demands on the committee for the supply of electric light have been increasing, and they were soon under the necessity of making extensions and alterations. Without tracing each particular addition, let us detail the plant as it stands to-day. There are seven engines: two Willans of 150 h.p. each, two Willans 90 h p. each, two Willans 300 h.p. each, and one inverted vertical marine type, by Marshalls, of 150 h.p.; the total horse-power thus being 1,220. All the engines are compound, and working at a steam pressure of 140lb. per square inch. Each engine is also coupled direct to its dynamo. These dynamos are by Siemens Bros. and Co, are continuous current, and work at a pressure of 150 volts. There are four Lancashire boilers, 7ft. in diameter by 28ft. long, and one of Babcock and Wilcox's water-tube boilers. One of the boilers is fitted, experimentally, with a mechanical stoker; but the others are fed by hand. Arrangements have also been made to economise as much as possible, and with that end in view, a Green's economiser of 240 pipes has been fitted in the flues, in order to utilise the heat from the waste gas and boilers. The exhaust steam also passes through the water-heater, thus economising as much as possible in fuel. There are also storage cells capable of storing 1,000 ampere-hours, and in consequence there is no necessity for the machinery to be in operation during the whole of the time consumption is taking place. In fact, although there is a supply of electricity for customers, the machinery does not run during the nights nor on Sundays. The maximum productive capacity of this plant is 19,000 lamps of 8-c.p. each. As a matter of fact, there at present are equivalent to 21,000 such lamps fixed, and being mostly in connection with shop property, the average number in use at the same time is high. The mileage of cables laid in the borough, including feeders, is about 21 miles. The system in use in Bradford is the two-wire continuous current, and we have the authority of Mr. S. M. Baynes, the Corporation electrical engineer, for stating that it is working satisfactorily. At present, owing to the large and increasing demand for the electric light, there is a probability of the three-wire system being adopted, but we are assured this is not because of any defect in the present system. According to a report presented to the members of the Electricity Committee Mr. Baynes estimates that to double the present two-wire system of the borough would cost £9,630, whereas the cost of putting in the third wire, which would practically double the capacity of the mains, would only be £5,970. In addition to that, also, there would be a saving in the working expenses of the three-wire system over the two of £424 per annum. No definite action has as yet been taken in the matter, but the committee have the report under consideration. Coming to the cost of electricity in Bradford, as compared with gas, we are informed it is just about double, taking candle-power for candle-power. Fivepence per unit is the charge for electricity in the borough, and the cost of gas is 2s. 3d. per 1,000 cubic feet. At this point it will probably be interesting to note the results obtained in Bradford as compared with a number of private companies in various parts of the country. From a table prepared on this subject, we find that the price charged per unit in Bradford is among the lowest. At Newcastle-on-Tyne the price is 4½d. per unit, Newcastle and District charge 6d., and in other places from that up to 10d. per unit. Newcastle-on-Tyne, however, writes off nothing for depreciation on buildings, plant, and machinery. Newcastle and District only ·46, whilst Bradford allows 1·10 in this respect. Again, whilst Bradford, in the way of redemption fund for recoupment of capital expenditure, allows ·99, Newcastle-on-Tyne allows nil and Newcastle and District only ·23. Taking the total cost of works, Bradford is a long way the lowest, with 1·67, Newcastle-on-Tyne being 2·23, and Newcastle and District 2·85. The highest is Southampton, with 16·46. In the total cost of management, Newcastle on-Tyne is lowest, with 2·61, Bradford is 4·04, and Newcastle and District 4·08. The highest is again Southampton, with 32·24. These figures are based per unit delivered to the customer, and it will be seen that Bradford, though a corporation, will stand very favourable comparison with private companies engaged in the same business. The total amount so far expended on capital account at Bradford is £48,568. 12s. 11d., these figures including everything expended on buildings and plant. The general balance-sheet at the end of last half-year showed that they owed to the bank £4,380, that there was owing on account of loans £47,291, and that they had paid through sinking fund from the commencement £3,198, all of which had come out of revenue. Taking the balance-sheets from the beginning, it will be found that in 1889 there was a loss, including payments on account of sinking fund and interest, of £1,079; in the half-year ending June 30, 1890, a loss of £732; in the December half-year a loss of £315; and in the first half-year of 1891 a loss of £30. For the second half-year of 1891 there was a profit of £970; for the first half-year of 1892 a profit of £387; and for the last half of the same year a profit of £1,089. These figures, added together, show that from the commencement the electricity department of the Corporation has extinguished the whole of the loss resulting in the earlier stages, besides paying interest and sinking fund, and that there has been a clear profit up to the end of last year of £289. 15s. 7d. It will be seen, therefore, that the electric lighting department of the Bradford Corporation is not a burden on the ratepayers, but promises to become a source of considerable revenue in years to come. The present works are being enlarged to practically double their present size, and there are numerous customers ready to take the light immediately the area is extended. Bradford has no reason to regret having led the way to other corporations in this enterprise, and they must be congratulated on the results achieved. The engineer in charge of the works is Mr. S. M. Baynes.

Government Enquiry at Taunton—On Wednesday, last week, a public enquiry was held on behalf of the Local Government Board by Mr. Thomas Codrington, M.I.C.E, respecting an application for a loan of £16,000 for the purpose of taking over the electric light works of the Taunton Electric Lighting Company. Besides the inspector named there were present the Town Clerk (Mr. T. Meyler), the Borough Surveyor (Mr. Smith), Mr. H. E. Hunt and Mr. Elakie (of the electric light station), the Mayor (Alderman W. H. Fowler), Alderman H. J. Van Trump, Alderman W. M. Chapman, Alderman J. Standfast, Alderman W. Adams, and many members of the Council, Mr. Edwards (gas company), Dr. Penny, and other memorialists, etc. The town clerk first read the notice which had been given announcing the meeting. The Inspector enquired if there were any other bodies represented besides the Corporation. Alderman Standfast said there might be, but there was some misunderstanding about the time, as the usual hour of meeting for the Council was 10.30. The Town Clerk gave the usual statistics connected with the borough. It was governed by a local board of health up to 1877, in which year it was incorporated In 1871 there were 15,466 inhabitants; in 1881, 16,614; and in 1891, there were 18,026. The suburbs had also largely increased, more in proportion than in the town itself. The ratable value was £63,626 in 1881, and £76,423 at the present time. A penny rate produced about £260. The area of the borough was 1,245 acres, and the present debt was £65 075. 19s. 1d. There had also been sanctioned a sum of £5,000 for sewage works, and there had been an enquiry held in respect to a loan of £9,672, made up of £5,300 for new street, £3,922 for recreation ground, and £450 for street improvement. The enquiries that day were for £5,000 for the new bridge and £16,000 for the electric light. That made a total debt of £100,747 if the Local Government Board agreed to the works now proposed. The general district rate was about 2s. 6d. in the £, generally made up of three tenpenny rates, sometimes less and sometimes more. The borough rate, which was paid out of the poor rate, was about 3½d. in the £. Taunton was a great railway centre and was the market town for a large district; a great many people came to the town to take advantage of the shops and market. With regard to the question of electric light, Sir Thomas Blomefield, who held an enquiry at Taunton, said it was the best-lighted town he had ever seen. The streets at present lighted by electricity were 3½ miles, a length of circuit of seven miles. There was an old-established gas company in the town, the capital of which was £35,000, and it paid from 7 to 8 per cent. It was consequently a very flourishing concern. The price of gas cost 4s. per 1,000, less discount. The main roads of the town were five miles, and eight miles other roads. Several new streets had been made, and the Council had made application to the gas company to light those streets. The company replied that it would not pay them to carry mains to the streets in question unless a higher rate was charged or a certain amount of private consumption was ensured. Therefore, oil lamps, 27 in number were used. In December, 1886, a company was formed to supply electricity, and it had worked until the present without any license The inhabitants had offered every accommodation to them and the Corporation had allowed them to carry the wires and posts throughout the borough. That showed how very popular the electric light was in the town. The land on which the works were established was valuable, as it had frontages to two streets. Suitable plant and machinery had been erected, and as a system of lighting it had been most successful. An electrical exhibition had been held and was largely attended. A number of deputations, one from the City of London, had been to the town to learn something from a small town like Taunton. In 1886 about 80 gas lamps were removed and replaced by 29 Thomson Houston arc lamps, giving an enormously increased light. In 1890 two extra electric lamps were added, replacing eight gas lamps, and in 1892 five others replaced 15 gas lamps. There were a great many arc lamps in private use, about 41 in number, and the incandescent lamps numbered 468 in 1891. The electric light company becoming embarrassed owing to want of capital, the confidence of consumers in the continuance of the light was shaken. When it became known that the Corporation proposed to take over the works, confidence was restored. In December, 1892, the incandescent lamps numbered 975, and at present there were 1,008. None of the large buildings in the town had as yet taken to the electric light, and that might be hoped for when it was in the hands of the Corporation. This included the railway station, the barracks, the hospital, and three large colleges. The average cost to the borough for lighting before electricity was substituted, was calculated at £847. 1s. 3d., and since then it was about £1,345. 7s. 6d.—an increase of about £500 per annum. But that included new gas lamps and oil lamps that became necessary in consequence of the increase of the borough. Mr. Meyler then traced the proceedings to show how the town came to acquire the works. He said that since he had been in correspondence with the Board above, he had heard that the provisional order had been granted, although it had not yet been passed through Parliament. It would become law at the end of the session, about July or August. The Council asked for 30 years in which to repay the loan of £16,000, the annual payment being £842. The present quotation for Corporation stock was quoted at 99½. Mr. Standfast complained that the committee had not been called together to consider the matter. The Town Clerk said it was the sub-committee and the Town Council were prepared to stand by it. Mr. C. P. Clarke said he appeared for the householders and others in the neighbourhood of the works who had complained of a nuisance which was admitted to exist there. He appeared on that occasion to repeat the protests made at the previous enquiry, in order that they might receive something in the nature of an undertaking that the nuisance would be abated. At present he did not see any provision in the estimate to cover the cost of abating the nuisance complained of. The Borough Surveyor (Mr. J. H. Smith) then made a statement about the proposed alterations in the plant. The wires will be placed underground, and the length of circuit would be reduced thereby. The new cables would cost £1,290. There would also be various alterations and additions at the depôt, including a smoke annihilator and a mechanical stoker. He said the vibration would be stopped. Mr. Blakie, assistant electrician at the works, said the business had largely increased since the Corporation had proposed to take over the works. The cost of 3½ miles of cable was £1,290. Mr. A. E. Perkins, the proprietor of the Castle Hotel, said that place was lighted throughout by electricity. It cost about £500 or £600, and it gave general satisfaction. He heard that the general opinion was that it would be a great blow to the town if the light was discontinued. Visitors to the town expressed their delight with the light in the streets. Personally speaking, he would not go back to the gas on any account. Mr. A Steevens said he had 166 electric lamps in his premises. Gas would not suit his places, and he would not care to go back to gas. When he was a candidate for municipal honours he made it plain that he was in favour of the electric light, and he was returned unopposed, as no candidate in the gas interest could be found. Alderman Standfast said that system had not been in use very long. He understood that Mr. Steevens used to pay 6s. a lamp, whereas it would take 18s. 9d. to make it pay. The ex-Mayor (Alderman W. M. Chapman) also gave evidence as a consumer of the electric light. He had 120 incandescent lamps, of 16 c.p. He had lately made alterations, replacing arc lamps with incandescent. He considered the electric light more healthy for the assistants in his shops and it was a clearer and better light than gas. So far as he knew, public opinion was decidedly in favour of taking over the light. Councillor W. H. Westlake spoke in similar terms. He said that since the electric light was introduced he had had two arc lamps outside his shops, and he would be very sorry to lose them. He had never heard a working-man say that he was opposed to paying his share to have the light retained in the town. The only thing he had heard against the electric light was that he had heard that morning about smoke and vibration. Mr. E. Sale asked about the way the members of the Council interested in the company had voted on the question of electric light. He alleged that 10 members who were interested had voted. Councillor Steevens pointed out that the shareholders would not receive a single farthing, as the debenture-holders would take all the money. Alderman Standfast said he was not surprised to hear that, and it was evident that the company had lost £12,000 in two years. Mr. Standfast went on to say that as the lamps generally were put out so early, the town was left open to burglars. He also spoke of what he considered would be the enormously increased cost of the electric light, which he estimated at £2,975 per year, including £500 for depreciation, amounting to a 1s. rate. The recent alteration in the prices of electric light was also commented on by the speaker, and he said it was a very nice arrangement for the company. Councillor Westlake said it had always been the custom of the Council to have the lamps put out early in the morning. Mr. Edwards said that before the electric light was introduced it was the custom to extinguish two-thirds of the lights at midnight and the rest at six o'clock. Recently one-third were put out at midnight and two-thirds at 2.30 in the morning. Councillor Lock complained of the way the Council had treated Mr. Kapp's report. Alderman Chapman said all calculations were based on that report, although they did not agree with its conclusions in other respects. The Town Clerk said the Town Council could not possibly act on the lines of Mr. Kapp's report, as his recommendation as to the kind of system to be used was quite against the experience of the town. Mr. A. E. Perkins said Mr. Kapp only recommended the Council to take over a part of the works. It was a question of system which made the Council go against Mr. Kapp. If the Council had agreed with him, they would have had to ask for a loan of several thousand pounds more than they were doing. Mr. Standfast having alluded to the accounts of the company again, the Town Clerk said the electric light company did not care to have their books overhauled by such an eminent man of figures as Mr. Standfast. If that gentleman had the dealing with the figures he would doubtless electrify the Council as well as the company. Alderman Standfast objected to the way he was spoken of as "dealing with the figures." The Town Clerk said the Town Council allowed a competent accountant to look into the figures of the company. Mr. Sale, in the course of a long speech, said a poor town like Taunton could not afford to spend money on what he considered was an expensive toy. The part of the town in which he lived was subject to floods and it was most likely that that question would be overlooked. Mr. Clarke also spoke at length on his side of the case, and the enquiry then closed.

PROVISIONAL PATENTS, 1893.

April 17.

7756. **Improvements in the process of obtaining chlorates of the alkalies or of the alkaline earth metals by electrolysis.** William Taylor Gibbs and Stanislaus Paschal Franchot, P.O. Box 1,071, Ottawa, Canada.

7758. ***Improvements in electric fire-alarm apparatus.*** Ernst *Kloss, 4, Moorfields, London.* (Complete specification.)

7782. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

April 18.

7806. **Improvements in portable telephones.** George Lee Anders and Walther Köttgen, 10, Jeffrey's-square, St. Mary's-axe, London.

7848 **Improved method of indicating telegraphic messages.** Joseph Levi, 33, Chancery-lane, London.

7865. **Lightning arresters and discharge protectors.** Elihu Thomson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7866. **Lightning arresters.** Elihu Thomson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

April 19.

7893. **Improvements in junctions for underground conduits for electric wires.** James Patterson and John Shaw and Co., 154, St. Vincent-street, Glasgow.

7897. **Improvements in galvanic batteries for utilising the waste.** William Jones, 7, Goldney-road, Clifton, Bristol.

7935. **Improvements in arc electric lamps.** Elie Victor Buchet, 28, Southampton-buildings, Chancery-lane, London.

April 20.

7991. **Improvements in prepayment mechanism, applicable to gas, electricity, and like meters.** Stephen Simpson, 13, Temple-street, Birmingham.

8004. **Improvements in or connected with electromotors, more especially applicable to the propulsion of vehicles.** Ernest De Pass, 78, Fleet-street, London. (Maxime Johannet and G. Dupont, France.)

8035. **Electroplating aluminium.** Harry Douglas Cunningham, 4, South-street, Finsbury, London.

April 21.

8087. **Improvements in arc electric lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

April 22.

8163. **Improvements in miners' electric safety lamps.** Ernest Bailey and George Mortimer Gordon, Broad-street House, Old Broad-street, London.

8176. **Improvements in electrolytic apparatus.** Cornelius Hanbury, 61, Chancery-lane, London.

8177. **Improvements in electrolysis.** Emile Andreoli, 61, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

4191. **Generating heat, etc., by electricity.** Farral. (Second edition.)

6126. **Electric signalling.** Radcliffe. (Second edition.)

1892.

3887. **Sending fire signals over telephone lines.** Stuart.

7492. **Electric bells.** Oppenheimer.

7826. **Electric lamp shades.** Froggatt.

8211. **Stopping or controlling electrical engines, etc.** Smith and Wilson.

9148. **Swing joints for electric light fittings.** Ebbutt and Verity.

9850. **Fans operated by electricity.** Pickup and others.

10430 **Electrical insulating sheet.** Wood. (Jefferson and another.)

16624. **Electricity meters, etc.** Fairall.

18363. **Dynamo-electric machines.** Thomas.

1893.

538. **Electromagnetically-heated receptacles, etc.** Mitchell.

2696. **Writing telegraphs.** Newton. (Gray.)

3398. **Electrical insulating material.** Gentzsch and others.

3461. **Writing-desk, etc., for telephones.** Nestler.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6¼
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

with the obtaining by them, or any opposition to the obtaining by any other local authority, company, or person of any license, order or special Act may be defrayed out of the local rate.

Local Authorities get Preference.—The Board of Trade gives local authorities the preference in applications for provisional orders, but this preference is conditional on the orders so granted being put in force within a term of two years, failing which the Board of Trade have power to revoke them and grant provisional orders to individuals or companies.

Revocation of Order.—The Board of Trade have no power to extend this time of two years but if satisfied that the local authority has a bonâ-fide intention of putting the order in force, they will not for a reasonable time revoke the order.

Expenditure Approved by Local Government.—The maximum price to be charged to consumers under the order is fixed. The expenditure by the Local authority must be approved by the Local Government Board and the electric system, plant, works, mains, meters to be employed are subject to the approval of the Board of Trade.

Enquiry by Local Government Board.—In case of opposition to the expenditure by the ratepayers, the Local Government Board can hold an enquiry and decide whether the expenditure is justified or not.

RULES OF BOARD OF TRADE.

Every application for a license or provisional order must be made by memorial addressed to the Board of Trade, accompanied by six copies of the proposed license or order.

Notice as to Objections.—There must be a notice at end of draft stating that objections are to be made by letter addressed to the Board of Trade, and sent in the case of a provisional order on or before the 15th January, and in the case of a license, within two months from the date of the newspaper containing the first advertisement of the application.

The draft must contain amongst other things:—

A description of the proposed area of supply.

A general description of the proposed works.

Conditions of supply including price.

A published map of the district on a scale of *not less than six inches* to the mile, showing the boundaries of the proposed area of supply, and the streets along which it is proposed to place electric mains.

Deposit of Maps.—The applicants must also deposit a copy of the said map for public inspection.

In England or Ireland, in the office of the clerk of the peace for every county, riding, or division, and of the local authority of every district.

In Scotland, in the office of the principal sheriff clerk.

Such deposits must be made in the case of a license when the memorial is lodged, and in the case of a provisional order by the 30th November.

Capital Expenditure.—A statement of the capital proposed to be expended and employed in connecwith the undertaking and the mode in which such capital is to be provided.

Consent of Local Authority.—A fee of £50 to cover ordinary expenses. Where the approval or consent of any local authority is required to any application for a license or order, it must be given by a resolution passed at a special meeting of the local authority held after one month's notice of the same.

The advertisement is to be inserted once at least in each of two successive weeks in one and the same local newspaper, and once at least in the London, Edinburgh, or Dublin Gazette as the proposed area of supply is situate in England, Scotland or Ireland. The advertisements must be inserted in October and November. A copy of advertisement must be deposited on or before the 30th November at the Board of Trade.

The memorial must be lodged on or before the 21st December.

The Parliamentary agents must be prepared to prove compliance with the provisions of the Act and the Rules by the 15th January and all such proofs must be completed on or before the 22nd February.

TIME TABLE.

For Licenses.—Resolution of local authority to be convened by one month's notice.

If application is entertained, applicants must advertise and objections can be made to the Board of Trade within two months from date of first advertisement.

For Provisional Orders.—Last day for notice to local authority where company or person is applicant	1st July.
Last day for inserting advertisements	30th November.
Last day for lodging memorial	21st December.
Day on which proof of having complied with Acts and Rules must be ready	15th January.
Last day for objections	15th January.
Last day for completing proofs	22nd February.

DEFINITIONS.

The subject of electricity appears at first to be very difficult to understand, because it is obscured to a great extent by a number of technical expressions which are incomprehensible to the uninitiated.

In this little exposition such terms will be avoided as far as possible, but there are two or three which it is absolutely necessary to comprehend in order to get any idea of Electric lighting.

Electric Units. Three.—The chief technical terms used in electricity are the *Volt*, the *Ampere* and the *Watt*.

A fairly good comparison with electric power may be obtained by assuming a hydraulic system of water pressure in mains.

Suppose water to be conveyed in pipes of one cubic foot area at a pressure of 1,000 lbs. per square foot and the water passes at the rate of 100 feet per minute and works a lift. The power used to work the lift would be 100,000 foot lbs. per minute, and as a horse-power is 33,000 lbs. raised one foot in a minute, three horse-power are required to work the lift.

Volt and Ampere.—Now the *Volt* is the unit of force corresponding to the pressure of the water and the *Ampere* is the current or quantity passing in unit of time, and just as you get in water the power by multiplying the quantity by the pressure, so do you also get in Electricity the power by multiplying the Volt or pressure by the Ampere or quantity.

Watt.—The volt multiplied by the ampere is called the *Watt* and is the electric unit of power and 750 watts (actually 746) make one horse-power.

To complete our comparison with hydraulics we might suppose the lift to be worked electrically instead of by water-power.

As shown above, the lift required about 3 horse-power to work it and 3 horse-power is about 3 × 750 = 2,250 watts. Let us assume a pressure of 50 volts and a current of 45 amperes which would give the 2,250 watts—then our comparisons would stand thus. The lift would be worked

	PRESSURE.		QUANTITY.
1. by Water	1,000 lbs.	×	100 feet per minute
2. by Electricity	50 volts	×	45 amperes

POWER USED.

1. 1,000 × 100 = 100,000 = 3 H.P. (about).

2. $\overset{V}{50} \times \overset{A}{45} = \overset{W}{2,250}$ = 3 H.P. (about).

V = volts. A = amperes. W = watts.

It will be seen later that an incandescent lamp of 8 c.p. requires about 30 watts per hour, and an arc lamp of 1,000 c.p. about 250 watts per hour.

Dynamo.—Power is converted into electric current by means of the dynamo. Faraday discovered that by rotating a free loop of wire between the poles of a magnet (say a horse-shoe magnet with which everybody is familiar) a current was created in the wire and the pressure of the current developed depends on the number of wires that pass the poles of the magnet in a given time. All dynamos are extensions of this fundamental principle.

A dynamo is generally spoken of as a 100, 200, 300 unit machine; a unit being 1,000 watts. It takes about 1½ horse-power per unit to drive the dynamo. Thus a 100 unit dynamo requires 150 horse and a 200 unit 300 horse-power to drive it.

Accumulators.—Accumulators, sometimes called secondary or storage batteries, store up electric energy which can be given out when wanted.

They consist essentially of plates of some metal, usually lead, immersed in dilute sulphuric acid, the plates being prepared so as to be readily acted on chemically.

When the current is passed, the plates by which the current enters are oxidised, while the oxide on the other plates by which the current leaves, is reduced to spongy lead. The effect is, in short, to set up a difference of chemical level. When charged, the batteries can be discharged by connecting to a circuit through which a current can flow.

There is a certain loss of power in charging the cells, and the depreciation is considerable, but notwithstanding these drawbacks there is a large field for them, especially for small installations.

The cost for accumulators is about £2 10s. per lamp.

Incandescent Lamps.—The Incandescent or glow-lamp is made in various sizes, but those in general use are the sizes which give a light equal to 8 or 16 candles.

The 8 candle lamp requires about 30 watts per hour to light it, and the 16 candle lamp about 60 watts. The pressure most generally fixed for incandescent lamps is 100 volts.

Arc Lamp.—The Arc lamp is mainly used for street lighting or for large interiors and is usually made in sizes giving a light equal to 1,000 or 2,000 candles and requires a power of 250 watts for 1,000 candle-power lamp, and 500 watts for 2,000 candle-power lamp. The force most generally used for Arc lamps is 50 volts per lamp.

Board of Trade Unit.—The Board of Trade Unit for the supply of Electric current has been fixed at 1,000 watts for one hour and a maximum charge per unit of 8d. Some of the London companies have already lowered their charge to 6d. per unit and one or more provincial companies are charging 4½d.

As an 8 candle-power lamp requires 30 watts, 1,000 watts would supply 33-8 candle-power lamps for one hour, or 16-16 candle lamps for the same time.

From the above we get the following standard figures:—

150 horse-power drive a 100 unit dynamo supplying 3,300-8 candle-power lamps, so that if we require to have a station capable of supplying current to 9,000-8 candle-power lamps we should require dynamos yielding in this aggregate 300 units, and driven by engines of 450 horse-power.

SYSTEMS OF DISTRIBUTION.

These are broadly divided into two distinct systems called the "Low Pressure" and the "High Pressure."

The Board of Trade has drawn the line of demarcation between these two systems and defines low pressure as anything under 300 volts and high pressure as anything above 300 volts.

Low Pressure.—The low pressure direct current system consists in distributing the current created by the dynamos, direct to the lamps (usually at *100 volts) with or without* secondary batteries the supply station being comparatively near to the distributing area.

Some electricians advocate the low tension system even where the station is as much as a mile or more from the area to be lighted; it is generally conceded however, that this distance of a mile is the limit at which the low pressure plan can be economically employed.

Taking the minimum standard employed for copper conductors which allows 1,000 amperes as the maximum current per square inch sectional area of copper, the loss of voltage is 2½ volts for every 100 yards, or 44 volts per mile. It will therefore at once be seen what a great advantage is gained if current is transmitted at high pressure, for at 100 volts 44 per cent would be lost in a mile while at 1,000 volts only 5 per cent of the pressure is lost.

In consequence of this loss the low pressure plant has to be made 40% larger than if high tension were used, and at full power 40% more electrical units have to be made than are paid for.

This loss can be reduced by making the copper conductors larger, but this adds greatly to the cost of the mains. A modification of the above system has been introduced for electric distribution in order to increase the pressure in the cables without augmenting it in the lamps, called the three, four and five wire system.

3 wire	...	200 volts in the mains.		
4 wire	...	300	,,	,,
5 wire	...	400	,,	,,

In all these cases the pressure at the lamps is kept uniform at 100 volts, but the increased pressure in the mains results in diminished loss in transmission between the distant generating station and the area to be lighted.

High Pressure.—High pressure current can be transmitted either by what are called the Alternate or the Continuous current system, also called Direct current.

The Alternate system is so called because the current is caused to rapidly flow alternately in opposite directions in the conductors; while in the Continuous system it flows uniformly in one direction. It is not necessary for our purpose to understand why some electricians prefer one and some the other, as the reasons are purely technical.

It is not strictly true to define the high and low pressure systems as perfectly distinct. The low pressure is purely low pressure from first to last, but the high pressure is a combination of high and low pressure.

In the high pressure system the distributing mains are the same as in the low pressure. The difference is in the pressure at which the current is transmitted from the Central station to the distributing area and its conversion from high to low pressure by means of transformers.

The difference between the Alternate and Continuous current lies chiefly in the form of transformer that has to be used.

Continuous Current Transformer.—The Continuous current transformer is like a dynamo in so far that it rotates, is in fact a piece of moving machinery which requires attention.

Alternate Current Transformer.—The Alternate current transformer is extremely simple and cheap. It consists of a single cast iron water-tight box containing plates of iron and wire. The high tension cable is led in at one end and the low tension is led out at the other end. There is no motion about it and it requires no attention, for there is nothing to get out of order. The cost is about £3 per Board of Trade Unit. It can be placed where required in a house, in a cellar, or under the street pavement.

As a general rule 2,000 volts is used for transmission, although at Deptford, the London Electric Supply Company employ 10,000 volts, but transforming down to 100 volts for the low pressure distribution.

As regards choice of system there is no best, but each is best for particular circumstances.

If the area to be lighted is a concentrated district with a place for a central station conveniently situated close at hand, then unquestionably low tension is applicable. On the other hand if you have to supply a straggling district from a station some distance off, the high pressure system becomes necessary.

These are extreme cases and between these two there will be various circumstances in which judgment alone can decide what system is best.

In certain low tension systems which have been started it has been found essential to have 3 or 4 separate stations each with running machinery and the great economy of one station and one supervision is lost.

In the high tension system complete freedom of choice in selecting a site for central station is given and it is probable, as town electric lighting extends, the advantages of being able to place the station outside the town with facilities for getting coal and water will be appreciated, and the high pressure system will come into general use.

On the Alternate current system the low tension distributing mains (say 100 volts) are laid down on each side of the street to be lighted and a high tension main (say 2,000 volts) on one side only. As often as convenient, depending on the number of lamps to be supplied—say at each 300 yards or other suitable distance—a transformer buried under the pavement receives the current from the high tension main at 2,000 volts and reducing it down to 100 volts feeds into the low tension distributing mains at each side of the street. The low tension mains are fed and maintained at a constant pressure, the distance between the transformers being such, that perfect regulation of the current exists along the entire line to be lighted.

Professor Fleming has made a careful comparison between a low pressure and a high pressure feeder of a mile long, each giving a maximum supply of 24,000 watts.

He finds that the low pressure feeder costs £1,000, and the high pressure feeder costs £500, and the annual cost of the former is £111, and of the latter £96.

As to the choice between the two high current systems, the Alternate and Continuous, circumstances must again decide which is best for adoption.

As explained before, the Continuous transformer being a piece of moving machinery, is costly, and so many tranformers could not be used on account of expense and the difficulty of placing them as on the Alternate system. Consequently the same constant pressure could not be maintained in the distributing mains as if the Alternating system were employed.

On the other hand, if it be considered advisable to employ secondary batteries, these can only be used with Continuous current and not with Alternate current.

Use of Motors.—It was at one time thought it would not be possible to use the Alternate current for driving motors but this is not correct. The use of motors has hardly come into use at all in this country but should progress be made in this direction it will be of great advantage to electric lighting as the plant now standing idle all day will be utilised and bring in an increase of revenue.

Load Factor.—One great source of expense in electric lighting stations is that a plant has to be provided capable of supplying the maximum number of lights, but this demand on the full capacity of the machinery only lasts for a few hours and the rest of the time it is standing idle. The term load factor is applied to express the ratio between the total number of Board of Trade Units the machinery is capable of supplying, and the actual number of units supplied.

This load factor varies in different towns and localities. In Kensington the load factor for the whole year is 12½ per cent, in St. James' and Pall Mall it is very high, 24 per cent, chiefly owing to clubs. In Newcastle it is 8·16 per cent.

The best clients for a lighting company are clubs, and then come restaurants, then theatres, then shops and lastly private houses.

DRIVING POWER.

Water-Power.—Where water power is available in reliable quantity this is of course the best motive power, but in England there are not many places where this can be found, but there are some towns where sufficient water power to drive the machinery for the day lighting is at hand, and by this means a great saving can be effected.

Failing water-power, the only practical power for central lighting stations is that of the steam engine, and the followinng types of engines present distinct advantages.

The steam turbine.

The quick running enclosed engine.

The vertical open type marine engine.

The horizontal slow running engine.

The steam turbine appears to present the considerable advantages of simplicity, economy at low load, and the use owing to the high speed at which it runs, of a small and cheap dynamo. Actual practical data however, as to its use in work are not at present available.

The quick running enclosed type of engine has the great advantage of occupying small space and affording good economy, it is coupled up direct to the dynamo and is to be recommended for small sizes.

The horizontal slow running engine is naturally in great favour with people who have had to do with machinery—its quiet running, reliability, and small expenses for repairs present great attractions. It is, however, an expensive engine and must be used with belts or driving ropes.

The vertical open type marine engine appears to be the best for large dynamos, or if prefered, a horizontal engine but in either case coupled direct to the dynamo. The marine engine type has proved its economy and reliability in all our ships, while the horizontal engine has done the same in our factories.

In every installation it is advisable to have a couple of small engines and dynamos to be used for the light or day load, because the waste of fuel when an engine is running on a light load is very great. Engines should be designed to give the best and most economical results at 60 or 70% of their full power because practice has shown that they are mostly run at two-thirds of their maximum capacity.

GAS AND ELECTRIC LIGHT COMPARED.

One pound of coal will produce 5 cubic feet of gas, which will light a 15 candle-power gas jet for one hour.

One pound of coal by electricity will give a light equal to 32 candles for an hour. This is on the assumption that it takes 8 lbs. of coal to produce 1,000 watts, but in some instances this comsumption has been reduced to 6 lbs. and even better results will no doubt soon be achieved.

1,000 cubic feet of gas costing 3s. produces 3,000 candles.

11,250 watts at 8d. per 1,000 costing 7s. 4d. give by incandescent lamps 3,000 candles.

750 watts at 8d. per 1,000 costing 6d. give by arc lamp 3,000 candles.

It will be thus seen that taking a maximum price for current electricity by incandescent lamps is nearly 2½ times the price of gas while arc lamp lighting is only one sixth of the price of gas.

At 8d. per unit an 8 c.p. lamp costs ¼d. an hour.
,, ,, ,, ,, a 2,000 c.p. arc lamp costs 4d. ,, ,,

Although a 5 foot gas burner is supposed to give 15 candles it is found in practice that it takes 7½ cubic feet to give that amount of light. It must also be noted however, that the incandescent lamps do not give out after a time their full amount of light and it has been proved to be advantageous to burn them only for 500 instead of 1,000 hours. As the lamps cost now nearly 4s. each, this is extravagant, but this price will shortly be greatly reduced so that a better light will be obtainable having less expenditure of power and at a fraction of the cost of the present lamp.

Mr. Preece states that in nine great towns the average yearly consumption per 5 foot burner, is 3,000 feet of gas which at 3s. per 1,000 cubic feet is 9s. per burner per annum; and for a 35 watt lamp which is the equivalent of a 5 foot burner, the average consumption of energy in a year is 18 Board of Trade Units, which at 6d. per unit is also 9s. So gas at 3s. per 1,000 feet = electricity at 6d. per Board of Trade Unit.

Apart from the actual cost, the electric light possesses a number of advantages which must be appreciated in the long run.

The air is not vitiated or consumed, the heat given out by electric lamp is only one twentieth of that radiated by gas. The rays of electric light more nearly approach those of the sun than those of any other artificial light and are therefore less injurious to the eyes.

The ease with which the light can be turned on and off is a practical advantage, which explains to some extent the small consumption of energy per lamp mentioned above by Mr. Preece.

We have not at present sufficient data for making any comparison between the capital expenditure for gas and that for electric light because the latter have sunk a large capital in cables out of all proportion to the number of lamps, and the capacity of the central stations.

The capital expenditure of gas works is 36s. per burner and taking the cheapest electrical installation at present built, it is about 30s. per lamp.

CAPITAL EXPENDITURE.

As regards capital outlay, this may be taken roughly as amounting to £2 10s. per 8 candle-power lamp; at the same time it may be less and it may be a great deal more, depending on the locality and the extent to which mains, with a view to future lighting, would be laid down.

This £2 10s. might be analysed as follows for an installation of say 5,000 lamps.

	£	*s.*	*d.*
Generating plant	1	5	0
Transformers		2	6
Mains		16	3
Buildings		6	3
	2	10	0

An installation has been mentioned before as costing only 30/- per lamp. It is on the alternate **high tension system.**

The 30/- is made up as follows:

	£	*s.*	*d.*
Buildings		2	8
Plant		13	1
Switchboard, &c.			11
Pipe boxes and mains		9	2
Transformers		4	2
	1	10	0

COST OF PRODUCING ELECTRIC LIGHT.

As regards the cost of production of Electric light, no company has yet been working long enough to enable the best results to be obtained, but we give below the details of cost of production per Board of Trade Unit, of one of the best of the high tension and one of the best of the low tension systems for the year 1892.

	Low Ten.	High Ten.
	d	d
Coal	1·04	·66
Oil, waste, stores	·25	·22
Salaries and wages	1·33	1·05
Repairs and maintenance	·31	·34
Miscellaneous expenses including rents, rates and taxes	·47	·19
Management	·91	·24
	4·31	2·70
Price charged per B. T. U.	8d.	4½d.

It must not be inferred that the cost of the light by the high tension system is, as shown above, so much cheaper than the low tension. The figures are only given as being the best results yet published of the two systems, and it would not be fair to compare them, as the circumstances of the two stations are quite different.

INSTALLATION OF LAMPS.

One serious difficulty met with in towns is the hesitation of householders to incur the expense of wiring and fittings in their houses, especially if they have already gone to the expense of fitting gas. It is a matter for consideration therefore, with town councils, whether they should not institute some scheme of purchase hire for the fittings of shops and houses so as to facilitate the adoption of the electric light.

It may also be wise for local authorities to consider the advisability of themselves undertaking the wiring of houses, and in this they have a precedent in what is often done by the various corporation gas works.

The capital expended in wiring and fitting up houses is nearly as large as that spent on electric light stations, namely £2 10s. per lamp.

SUMMARY.

Having now drawn attention to the various points for consideration for any county or town council proposing to undertake lighting by electricity, the various steps may be summarised as follows:—

1. Fix on the area of supply and the number of 8 candle-power lamps.
2. Capital expenditure at £2 10s., or £3 per lamp.
3. Resolution of local authority approving the proposal for electric lighting convened by one month's notice.
4. Memorial to the Board of Trade to be lodged by the 21st December.
5. Proof of having complied with the Acts and Rules by 15th January, and such proofs to be completed by 22nd February.
6. On provisional order being granted, and system of lighting being decided upon get tenders for installation from responsible firms.
7. Expenditure must be approved by the Local Government Board.

NOTES.

Derby.—The light will be ready for supply at Derby by the middle of July.

Whitehall Club.—A dinner of the electrical members of the Whitehall Club will be held to-night.

Belgrade is to be lighted by electricity. The standards which are to support the arc lamps are already in position in the principal streets.

Milan.—The Milan Council have authorised the Edison Company to run an electric tramway experimentally for a year. The length is two miles.

Air Compressors.—Prof. Elihu Thomson has applied electricity to air compressors by utilising the heating effect of electricity for the expansion of the confined air.

Leeds.—The Mayor of Leeds will open the electricity station of the Yorkshire House-to-House Company, in Whitehall-road, Leeds, on Wednesday next, May 10.

Train-Lighting.—In Boston electric lamps are placed on some of the passenger cars under the sills near the steps, and as the car stops the lamps light up and show the way clearly.

Polytechnic.—Our note last week as to appointment as principal open applied to the Battersea Polytechnic, not the Borough-road, where the excellent principal, Mr. C. T. Millis, has no intention of vacating his post.

Lady Electricians.— According to *Woman*, Miss Millicent Fawcett, who so lately took academical honours, is turning her attention to electrical engineering. Electricity is a cleanly, delicate occupation. Why not lady electricians !

Chicago Congress.—A notice has been sent out by the secretary of the Institution of Electrical Engineers to ascertain how many of the members intend to be present at the Electrical Congress, which will be held in Chicago during August.

Derby Drainage.—The Special Drainage Committee of the Derby Town Council propose, on the advice of Sir Frederick Bramwell, to make experiments with an electric system of purification which has had success at Paris and other continental cities.

The Electropathic Belt Case.—Mr. Harness has, we understand, settled the libel case with *Science Siftings* out of court, the proprietors of that paper being advised by their solicitors to accept the compensation offered of £1,500 for damages and costs.

Friendly Rivalry.—In Aix, says the *Gas World*, a whole street-block of houses is being built so as to be entirely warmed by low-pressure steam from a boiler, the engine of which also works the electric light, while all the cooking is to be done by gas. There are no fire-places.

Accumulators.—Herr Winkler has a paper in the *Zeitschrift für Elektrotechnik* on the "Use of Accumulators in Central Stations," which is to be completed in the next number. Statistics and curves are given. Franz Streintz, the "Chemical Theory of Secondary Elements," in the same number (April 15).

Institution.—The full title of Mr. W. B. Sayers's paper before the Institution next Thursday is "On the Prevention of Sparking; Compound Dynamos without Series Coils or Magnets; and Self-exciting Dynamos and Motors without Winding upon Field Magnets." It sounds an interesting paper.

Cardiff.—At the meeting of the council of the University College, Cardiff, on the recommendation of the joint college and associated counties committee it was determined to purchase forthwith electrical engineering and lighting apparatus, together with a boiler and engine, at an estimated cost of £1,025.

Railway Starting Indicator.—The Allgemeine Company have brought out a convenient arrangement for showing the starting times of trains from stations. The names of stations and the hour and minute of starting are shown in bold letters in a framework, the indications being controlled by electricity.

An Electrical Novel.—"In a few days," writes "An Exile" from Paris, "there will be out an electrical novel, entitled 'The Shadow of Desire,' by Irene Osgood, published by the Cleveland Publishing Company, 19, Union-square, New York, U.S.A. Many of our well-known people are too palpably drawn."

Electric Light for Telescopes.—Mr. Edwin Holmes, in the *English Mechanic*, describes and illustrates a simple and cheap electric light for telescopes and other apparatus. The lamp, from Mr. Edwin Phipps, of Maidstone, seems to cost but 7d., and the rest of the apparatus (two E. C. C. dry cells, etc.) comes to a shilling or two.

Electric Mining.—Before the Mining Institute of Scotland at Hamilton, on the 27th ult., Mr. David Hunter's paper on "An Electrical Pumping Plant at Bent Colliery" elicited considerable discussion, and further consideration was adjourned. A paper was contributed by Mr. James Baird on "The Use of the Electric Light in Sinking Shafts."

Price of Electricity.—One of the most encouraging things in electrical distribution recently noted was the fact mentioned at the meeting of the Metropolitan Electric Light Company, that during the past year the amount of current sold showed an increase of 35 per cent., and this increase only entailed a cost of 4 per cent. extra on the working expenses.

Books Received.—We have received "The Romance of Electricity," by John Munro — the Religious Tract Society, Paternoster-row. From Messrs. Whittaker: "Electric Lighting and Power Distribution," Part II., with 85 illustrations, by W. Perren Maycock, price 2s. 6d.; "Electricity and Magnetism," by S. R. Bottone, with 102 illustrations, and "A Guide to Electric Lighting," by the same author, price 1s.

Electrotechnical Bibliography. — The German nation are great in bibliographies, careful indexes, and other painstaking and useful work. We have received notice of such a work, applied to electrical matters, in an "Elektrotechnische Bibliographie," published by J. A. Barth, in Leipzic, edited by Dr. Georg Maas, secretary of the Elektrotechnischen Gesellschaft of that town. It will be published monthly.

Electric Welding.—In Sheffield, welding by electricity seems to be becoming acceptable. Mr. Scott Anderson during the past 12 months has erected seven large plants for electric welding and annealing. As the electric furnace, which he recently showed in action in Sheffield, gives promise of better and more economical results, it will doubtless command much attention. Considerable interest is being felt in the district in the application of electricity to metallurgical operations.

Telephone Ear Cushions.—There are few things more tiresome and irritating than the holding of a telephone receiver to the ear. A Canadian inventor, says a contemporary, with a view of relieving this discomfort, has designed an air cushion made of hollow, soft rubber, which is fitted over the end of the telephone receiver. Not only is the device said to make telephoning more comfortable, but it actually assists the hearer, inasmuch as the cushion shuts out all external sounds. A small tube on the device enables the cushion to be inflated as desired.

Goebel Lamps.—The Edison Company having brought a suit against the Columbia Incandescent Lamp Company, of St. Louis, for infringement of the Edison patent, the Goebel lamps were again brought forward for the defence, the previous affidavits being supplemented by a vast amount of new evidence. The complainant submitted 120 affidavits and the defendant no less than 222. Among the exhibits were six Goebel lamps, three of the "meatsaw" type, and three "hairpin" pattern. Three of these were identified as having been made before 1879. Judgment was reserved.

Lyons Exhibition.—Lyons will hold a universal international exhibition in 1894, and the official bulletin showing the proposed building is before us. The principal hall covers a surface of 45,751 square metres, with a diameter of 232 metres. The Mayor, Dr. Gailleton, is at the head of the committee, M. Clavenad being the engineer-in-chief to the town. The design for the building was made by M. Claret. It forms an immense dome, with projecting lateral slopes, and is of handsome appearance. Electric transmission of power will be used throughout instead of countershafting.

Automatic Railway Signals.—Mr. Edwin Blakey, engineer to the Automatic Electric Railway Signal Company, points out a slight error in our description of the company's system of signals published in last week's paper. Instead of "the current is constantly on, keeping the signals at danger," the word "clear" should be substituted for "danger," as the signals in all cases go to "danger" by the force of gravity. That this was a clerical error is, however, clear from the context. It is one of the excellencies of the system that any interruption of the circuit would not permit accidents to occur.

Electric Flatirons.—The proprietor of a laundry at Lauter, in Germany, has adopted electric heating for 60 of the flatirons used in his establishment. A 40-h.p. dynamo provides current for heating, for lighting the lamps, and for driving motors for the various washing and wringing and mangling machines. The core of the flatirons is formed of asbestos covered with platinum wires, which are made incandescent by the current As current is cheap and expense is saved when the irons are not in use, the application is not found expensive, while the cleanliness and convenience is beyond dispute.

Dangers of Punting.—Before Justice Grantham, a case was settled last week anent the responsibilities of electric launches. One of the General Electric Traction Company's launches, it seems, ran into a punt carrying Mr. Elgood and his wife and Mr. Orlebar, and tipped the party into the water. This was after Molesey Regatta, at half-past 11 at night. The launch was going slowly when the punt shot out of the darkness and crossed the path of the launch under the bridge, shouting being not in time to stop her. Negligence was not apparent on the part of Mr. Herbert Wilson, who was in charge of the launch, and a verdict for the defendants was given.

Rochdale Technical School.—The new municipal technical schools were opened by Sir Bernhard Samuelson, Bart., at Rochdale on the 26th ult. He congratulated the town on the new venture, and spoke in favour of technical education. So far as he had seen, however, there was no provision as yet for the teaching of physics. For that, he thought, they should provide at an early date. For example, he thought they would have to train men who should be competent as tradesmen to provide them with light and heat for their houses from electricity. He left aside all the higher branches of electrical science. There were other branches of physics which were of equal importance, but it might be enough that he had given electricity as an example.

Illumination.— The following are Dr. Sumpner's figures obtained experimentally on the amount of illumination reflected from various surfaces: The amount of light reflected from a newspaper or piece of foolscap is equal within 10 per cent. to that reflected from a good glass mirror. Deduced from the results, we find that black cloth covering the wall of a room requires proportionately 100 candles to produce a certain illumination; dark brown paper, 87; blue paper, 72; yellow paint, 60; clean wood, 50; dirty wood, 80; cartridge paper, 20; and whitewash, 15 candles. It is thus seen that it takes nearly six times as much candle-power to illuminate a room papered with dark brown paper as it does to illuminate to an equal degree a whitewashed room.

Honours to Students.—The council of the City and Guilds of London Institute have elected Mr. H. A. Humphrey a Fellow of the institute. This distinction is conferred upon those who, having matriculated and successfully completed the course of instruction prescribed for regular students at the Central Institution, and obtained the diploma of associate, shall have spent not less than five years in the practice of their profession, and shall produce evidence of having done some original and valuable research work, or of having otherwise contributed to the advancement of the industry in which they are engaged. Mr. Humphrey obtained the diploma of associate in 1887, and is now engineering manager of the refined bicarbonate and crystal plant departments of Messrs. Brunner, Mond, and Co.

Liverpool Telephones.—The largest centre of telephonic communication in the United Kingdom, and one of the longest in Europe, remarks the *Daily News*, is that of Liverpool, where the National Telephone Company have just completed their new switch-room. This is a hall 90ft. in length, and is fitted in a way which completes nearly a million of telephonic connections, whereby each subscriber on the exchange may be placed immediately in connection with any other throughout the country. Already there are worked from the Liverpool centre 9,600 miles of line, of which more than 7,000 are exchange and private wires. In 1882 the mileage of wires in Liverpool was only 463 miles; in February last it was 7,019. From the last published statistics it appears that the number of "calls" in the Liverpool centre is 42,800 per day, representing a daily communication between 95,600.

Traction and Telephony.—A meeting of persons interested in electrical traction and of the Telephone Company was held at the Board of Trade on Wednesday, April 26th. The Telephone Company suggested to the Board of Trade that by reason of the proceedings on various Bills during the past four years the time had come for one of the protective clauses given to the Telephone Company to be adopted as a model clause, and so treated by the Board and the authorities of the Houses. In reply, Sir Courtenay Boyle, after hearing the views of those representing electrical traction, intimated that in their opinion the suggestion of the Telephone Company could not be accepted, but that they thought the time had come when the whole question could and should be considered with a view to a settlement, and intimated that they would consult the authorities of the House as to the proper steps to be taken to have the matter so settled. Sir Courtenay Boyle also intimated to the Telephone Company that they did not in the meantime propose to insert any clause for the protection of the Telephone Company in orders coming before them.

Electricity at the World's Fair.—"We come out poorly in the superb department of electricity," says the *Daily News* special commissioner at Chicago. "The Germans, who have been pouring out money like water, are masters of the situation, apparently, here. An eminent American electrician in Chicago became (for an American gentleman who has been a soldier) quite emotional as he deplored to me the fact. He lamented the absence of the chairman of the committee, Mr. Preece, at the opening, and thought England ought to be better represented by electrical exhibitors. The fact is we sing small in this department, and perhaps it is useless to enquire why. The explanation, if wanted, must be sought for at home, for Sir Henry Wood and others did all they could to produce a better result. The preliminary essay is by Prof. W. E. Ayrton on 'Electricity and Electrical Appliances,' and there is some kind of exhibit from the Postal Telegraph of the British Government."

Hodgkins Fund Prizes.—In October, 1891, Mr. Thos. George Hodgkins, of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." The Smithsonian Institution now announces a prize of 10,000dol. for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences—*e.g.*, not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge. Also a prize of 2,000dol. for the most satisfactory essay upon "the known properties of atmospheric air considered in their relationships to research in every department of natural science." A medal will be established, under the name of the Hodgkins Medal of the Smithsonian Institution, which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. The treatises may be written in English, French, German, or Italian, and should be sent to the secretary of the Smithsonian Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until December 31, 1894.

Aluminium Plating.—Some details of the large task of plating the ironwork of the Philadelphia City Building with aluminium will be read with interest. It appears that the process successfully adopted was devised by Mr. Darling, of New York. The first step was to construct tanks to hold the plating solution, and, as some of the pieces were columns 3ft. in diameter and 26ft. long, the tanks were necessarily of great size, that for the aluminium solution holding 7,000 gallons. After pickling the pieces of iron, they are first electroplated with copper. The copper film is very thick, 16oz. being deposited on each square foot of surface. This coating alone would protect the iron, but the copper would soon turn black and green by exposure to the air, so that the final coating of aluminium is added for appearance. From two to three ounces of aluminium per square foot is deposited over the copper, forming a very substantial film. Like most metallic films deposited from solution by electrical decomposition, however, the aluminium coating is porous, and while it is firm enough to adhere well, it is not sufficiently compact to resist the action of the atmosphere, which covers it with a grey coat of oxide. This effect of the air was foreseen, but the colour of the coat of oxide harmonises well with that of the marble which forms the main mass of the building, so that it is, if anything, preferable to the glitter of an untarnished surface, and it is found to be very superficial, and to protect the metal under it from further action. It remains to be seen how it will bear the long-continued action of the weather.

Kidderminster.—At the Kidderminster Town Council meeting on Wednesday, the Law Committee presented a report on the subject of electric lighting, and the result of enquiries on the subject. Mr. A. Bromley Holmes, C.E., of Liverpool, was selected to advise the committee on the subject. He advised the adoption of a low-tension direct current with a battery of accumulators to supply the current during the hours of small demand, when it would be uneconomical to run the engines. The costs of laying mains in all—or nearly all—the streets in the compulsory area, to erect buildings, and put down plant capable of supplying 3,000 16-c.p. incandescent lamps, the buildings being so arranged as to admit of extension, was approximately £15,000. Taking into consideration the moderate price charged for gas in Kidderminster, and the nature of the area of supply, Mr. Holmes did not anticipate that there would be at first a large demand for electric light, as the cost of electricity would be at least double that of gas. When the incandescent lamp patent expired in November next, much cheaper lamps of higher efficiency would be obtainable, and the time was probably not far distant when the electric light would compete with gas at equal prices. The committee, with the view of estimating whether the probable demand for electric lighting would justify the Town Council in taking the matter up, recommended that a circular be sent to all probable consumers in the compulsory area, enquiring whether they were prepared to accept a supply of electricity at an estimated cost of 6d. per Board of Trade unit, or equal to 5s. per 1,000ft. of gas. When the results of this application had been obtained, the committee would be prepared to make a further report.

Medical Electrodes.—Mr. R. Brown, in the *Brooklyn Medical Journal*, describes a new kind of electrode for external use in electro-medical operations. Felt or cotton are not satisfactory; clay has been used, but is cold and unclean. "Amadou," a species of fungus, is the material proposed, backed up by a mesh of metal. "Amadou" is a substance which grows upon old trees in England and on the continent of Europe. When prepared for market it has the appearance of soft leather. It will readily take up more than its weight of water, and in so doing contracts to at least half its former size. When saturated with water it has a fleshy touch, and will readily conform to the irregularities of the body. This substance will remain moist for a long time, and a sandbag, or other pressure, may be put upon it without fear of water running from it over the patient. It is exceedingly porous, and when thoroughly wet forms an excellent conductor. The current is evenly distributed over the whole surface covered by it, and consequently no burning spots are experienced by the patient. The metal used is a plaque or flat piece of perforated brass, known in the trade as No. 15. It is beautifully smooth on one side, and, owing to the punches of the machine in making the perforations, is slightly rough on the other. It can easily be cut with an ordinary pair of scissors to any desired shape, care being taken to follow the perforations in such manner as to leave an unbroken edge all around the plaque, as shown in the figure. After having cut a piece, as described, it should be annealed by holding it over the flame of a Bunsen burner, or placed on the hot coals of a fire until cherry red, and then thrown into a pan of coal water. This may be repeated, when it will be found to be as pliable as a piece of lead. Directions are given for attaching the electrodes and using them on the body.

Physiological Effect of Magnets.—Magnetism and electricity in their medical aspects, says the *Lancet*, have a peculiar, and too often unpleasant, interest, because of the halo of mystery which surrounds them. A recent paper in the *New York Medical Journal* by Dr. Peterson and Mr. Kennelly is an attempt to throw some light on the subject of the physiological effect of magnets of great power placed at the disposal of the writers at the Edison laboratory at Orange, New Jersey. It was found that blood placed on slides, covered with a cover-glass and subjected to the influence of a powerful magnet, failed to show the faintest trace of polarisation movement or vibration. The same held good of the living ciliated epithelium taken from the pharynx of a frog, and it was also found that the circulation in the web of a frog's foot observed under a high power failed to show any sign of being influenced. Benedikt has stated that magnetism "increases the resistance to conduction in motor nerves" and so causes paralysis. No effect at all was observed on a dog placed in a cylinder and subjected for five hours to a magnetic field of intense power. Five men, the observers themselves amongst the number, were also exposed to trial. Sphygmographic tracings taken continuously during the *séance* showed no irregularity of the pulse, and this in spite of the making and breaking of the enormous magnetic influence during the observation. The knee-jerk, also tested continuously, showed absolutely no change, nor did any one of the five experience any unusual sensations which could be attributed to the magnetism. Another series of experiments also had a negative result, and the conclusion reached was that the human organism is in no way appreciably affected by the most powerful magnet known to modern science, either as regards circulation, ciliary or protoplasmic movements, or sensory or motor nerves. The writers therefore express the opinion that the ordinary magnets used in medicine have a purely suggestive effect, and would be equally serviceable if made of wood.

Blackpool.—The foundation-stone of the Blackpool Corporation electric-light works was laid with great ceremony by the Mayor last Saturday. The foundation-stone bore the following inscription: "Blackpool Corporation Electricity Works. This foundation-stone was laid on 22nd April, 1893, by the Worshipful the Mayor of Blackpool (Alderman James Cardwell). R. Hammond, M.I.E.E., electrical contractor; J. Hesketh, borough electrical engineer; J. Wolstenholme, borough engineer." Alderman Buckley asked the Mayor to lay the stone, and Councillor Pearson hoped the Mayor would look back with pleasure to the day's proceedings. Mr. Hammond said he would like to say that, as electrical engineer and contractor for the electrical portion of those works, he considered that Blackpool was taking a very wise step that day. In nearly all the large towns throughout the country where the corporation owned the gasworks they were taking the same steps as Blackpool. He believed there was only one instance where an important town had fairly and squarely discussed the matter, and decided to let the business go into the hands of a company, and that was Leeds. Although that only took place two years ago, Leeds was now under a cloud of disappointment; and though the works had not yet got into operation, Leeds was considering the advisability of taking them up. The Mayor then declared the stone well and truly laid. The proceedings were followed by a banquet, at which Councillor Pearson said it was their intention to provide a number of lamps upon the Promenade which should light it up in a manner second to none on the whole continent of Europe. If they carried out completely the programme which had been foreshadowed by the committee, the Promenade would be lit up in such a brilliant fashion as to add enormously to the attractiveness of the town. It was intended that the lamps should be fixed on the Parade at a distance of not more than 45 yards apart along its whole length. They would thus get 101 arc lamps, each of 2,000 c.p., and not more than 25ft. from the ground to the arc itself. Everyone who knew the beauty of electric arc lamps could imagine the brilliance of the scene. He hoped they would be able to supply current at the end of July.

Long-Distance Electric Railways. — We have alluded several times to the project for electric traction on railways of M. Heilmann, who proposed to generate steam and electricity on a locomotive. This scheme will be tested on the French Northern Railway. The same railway will also test the plan of M. Sartiaux, who proposes to use 80 huge Laurent-Cély storage cells, weighing 40,000lb. His car is an old waggon, on each of three axles of which will be mounted a 30-h.p. motor. He hopes to get a speed of 60 miles an hour, or even more. The Paris, Lyons, and Mediterranean Railway will test the plan of MM. Bonneau and Desrozier, who propose generating stations along the route. M. Bonneau is assistant chief engineer of the railway, and intends to use water power, though the ingenious idea of using up the old locomotives or batteries to generate power at certain stations is mentioned. Another project is that of M. Kepes, who, we are told, has asked of the Austrian Government a concession for a line to be run at 110 miles an hour between Pesth and Presburg. A generating-station system would be adopted. In America long lines are being built by extension of shorter ones. A line between Baltimore and Washington (40 miles) is in hand. A 25-mile track is proposed between Harrisburg and Mechansville, in Pennsylvania. Between Scranton and Northumberland a company will construct a line 80 miles long, and distribute light and power at the same time. From Ohio a 70-mile track is proposed. Cincinnati and Dayton are to be connected. Two large combinations have been formed for a network of electric railways—one, the New England Street Railway Company, to connect all the larger New England cities and towns. The other proposes to connect Newark, Jersey City, Orange, and other large towns in New Jersey. The track for the line between St. Louis and Chicago has been begun, and although doubts are said to be expressed as to whether, after all, the line will not be first run by steam locomotives, it is pretty evident that if fast electric traction succeeds as it is expected to succeed, this line will certainly be run at 100 miles an hour with regular trains by electricity. We do not at present hear of any schemes for high-speed electric traction in England; indeed, the distances are mostly too short to warrant the enormous expense in an experimental stage. England may therefore expect to remain behindhand on this question until its possibility and advantages have been demonstrated.

Artistic Electroplating.—Among the numerous exhibits which are to be sent from the great hardware city to the World's Fair is a case of goods by Messrs. Ash, Gill, and Co., of the Betchworth Works, Birmingham, in which they show examples of their new process of electro-depositing on a non-metallic base. For many years past attempts have been made by different firms in the trade to achieve this result, but with only partial success, and, moreover, the process was attended with so much danger in consequence of the highly combustible nature of some of the agents employed, that manufacturers did not care to incur the risk of setting their premises on fire. Messrs. Ash, Gill, and Co., says a Birmingham correspondent, have discovered a process by which this danger is avoided, and the results are so satisfactory that the invention has been pronounced by practical men of long experience to be one of the most important that has been introduced in the electroplate trade for many years. The objects to be dealt with, whether they be a sprig of natural holly or ivy, a bit of common hedge briar, a fern, geranium leaf, a marguerite daisy, a terra-cotta group, or a piece of delicate lace, are first submitted to the process, which is the inventors' secret. They next receive a deposit of copper, which renders them perfectly ductile and practically indestructible, and then they are ready to be either silvered or gilt by the ordinary process of electroplating. The articles treated in this way are mainly intended for ornamentation, and some of the goods which Messrs. Ash, Gill, and Co. have prepared for Chicago are exquisitely beautiful. The leading object in their case is an electro-silvered centre-piece, with an artistic arrangement of natural twigs in dead work. Then there are biscuit, glove, and trinket boxes, and drinking-cups, with sprays of ivy or holly twined around, the veining of the leaves and the sharpness of the prickly edges of the holly being as perfect as they were in their natural state, while the dead work is beautifully reflected in the polished surface beneath. To other articles lace is attached in a similar manner, and while all the delicate gossamer appearance of the lace is preserved, its character is so changed that it has become metallic, and may be removed whenever the main article requires cleaning. For this purpose it may be remarked that in every instance the ornament is attached by screws, not soldered, for facility of removal. In the same way the ornamentation is applied to glove-boxes, the backs of hair-brushes, and an infinite variety of other articles, the materials employed being marguerite daisies, the leaves of the geranium, cineraria, maritima, etc., and be it remembered that in every instance it is the natural leaf and flower that is used. An *entrée* dish with the handles formed of twigs, which also serves as knife-rests, is both novel and artistic. A dinner gong, the gong being suspended from the bent branch of an ordinary briar, is unique and unconventional in design. Pretty groups of Devonshire terra-cotta ware treated by the patent process and bronzed make charming ornaments, and cannot readily be broken. There is an infinite variety of other articles, and the whole display is one which is sure to attract notice alike for its novelty and its artistic beauty.

City Guilds Institute.—The report of the City and Guilds of London Institute for the Advancement of Technical Education, just published at the Gresham College, Basinghall-street, makes very interesting reading. It is the thirteenth annual report, and it appears that there were 412 day students in the colleges, as against 382 in the previous session. The number of evening students is 1,500, mostly at Finsbury. The candidates examined numbered 8,534, as against 7,416 in 1891. Day students put in 1,200 hours a session, against 90 hours for evening students. The report alludes to the institution of polytechnics and the attempts that have been made to annex them for real technical training. The proposed teaching university for London the City Guilds Institute do not join. Any scheme by which the science teaching in London might be co-ordinated with economy in laboratories would receive their attention. The council regret, and we regret, that the Corporation of London have withdrawn their financial support. At the time when all other corporations are throwing themselves heart and soul into the work of technical education, the Corporation of London is the one to withdraw! At the Central Institution, South Kensington, under Profs. Unwin, Ayrton, Henrici, and Armstrong, the numbers attending have risen from 30 in 1885 to 199 in 1892. Additions have been made to the laboratories; the dynamo-room has been partly enlarged and rearranged, and the plant of a model electric lighting station has been erected. In the engineering department is an experimental steam-boiler arranged for testing. Mr. Heenan has presented a spherical steam-engine in recognition of good work by Mr. Humphrey and Mr. Gilbert, former students. Out of 200 students the council remitted fees in ten cases. At Finsbury, a Mordey dynamo, specially designed, has been ordered, and a new 10-ton testing-machine is being built. A sum of £1,000 is set aside for extension. Gross expenditure has been: Central Institution £11,248; Finsbury £9,352—or net cost, after deducting fees, £7,403 and £6,824 respectively: of which at the Central there are three professors at £1,000, and at Finsbury £800, £625, and £600, besides demonstrators and assistants. Materials and rates and taxes both average £1,000 each at both institutions. The report of the Central Institution alludes to the wretched teaching at most modern sides in schools—a place of refuge of weak intellects — the whole standard of teaching being low. A more distinctive name is required for the Central Institution—that of "The City and Guilds School of Engineering and Technology" is suggested. The successes are mentioned: Mr. F. H. Hummel's career has been "uniformly meritorious"; Mr. C. V. Drysdale was second, and continues his studies; the John Samuel scholarship was gained by Mr. H. C. Leake; and the Sir D. Salomon's scholarship by Mr. C. H. C. Woodhouse. Mr. B. B. Turner and Mr. F. Shelford have gone in for B.Sc. A list of past successes is given, ranging from professors, technical journalists, managers, assistants, to improvers. The report of the Finsbury College by the principal (Prof. S. P. Thompson) contains much interesting statistics of ordinary and special courses, the occupations of students, and result of past work. Mr. Millis, lecturer on metal work, has been appointed to the Borough-road Polytechnic. Four special courses were held: the principal on telephones, Prof. Perry on differential calculus, Mr. Reckenzaun on electric locomotion, and vector methods of calculation by Mr. W. C. Clinton. The library is not satisfactory; there is no special room, and the library of the institution, kept at the Central Institution, is too far off. Only one book has been presented last year! The electroplating department has collaborated with the art department to preserve students' work. The need of further electrical apparatus worthy of the recognised centre of instruction at Finsbury is noted. Every year sees past pupils in positions of greater responsibility. The latest success is that of Mr. H. D. Richmond, analyst to the Egyptian Government, who discovered a new element—masrium. The greatest requirement is an additional site—now vacant—for extension. An imposing list is given of past day-students, which requires revising, however. We recognise Mr. Dolby, consulting engineer, under the guise of Mr. Dalby, editor of *Electrical Plant*. The report concludes most interestingly with an account of the proceedings at the presentation of prizes on 12th December, when Mr. W. Anderson, president, M.E., delivered an address, here given in full. Mr. Anderson gave the history of Watt's great discovery, told in an inspiriting manner *pour encourager les autres*. The council are to be congratulated on the issue of this report.

THE TRAINING OF ELECTRICAL ENGINEERS.—IV.

We have said so much in the three previous articles animadverting against the training in technical colleges—backed up, it is necessary to point out, by the opinions of practical men—that it is a pleasure to be able to give a good word to the two London technical institutes at Finsbury and South Kensington, even if accompanied by doubts as to the perfection of the methods there employed, and regrets that a still furthur advance has not yet been made. The training given in mechanics, physics, chemistry, and electricity at these institutions is to a considerable extent on right lines. This is acknowledged, and is due to the persistent efforts of the promoters to make the technical teaching really "technical"—experimental and concretely analytical instead of merely theoretical and evolutionary. The good that has been done to the cause of technical education in general in this country in insisting upon this line has been immense; and some results are seen in the appreciation by certain firms of the students coming from these colleges, instances of which we are pleased to give this week. But the resolve taken that the teaching should be practical and concrete requires to be carried out further and further still. All the instincts and traditions of pedagogy are against it, and even in some colleges which definitely adopt these principles of education, their practice constantly tends towards the Jesuitical—*i.e.*, the "it-is-because-I-say-so" attitude, dear to professors in classical studies. The baneful *régime* of abstract theory, the desire of training for the sake of training hangs about, not only in odd corners, but in some studies still overshadowing usefulness in application. The ideal with which the promoters of the City Guilds schools set out so gallantly requires pushing home, until it should be impossible for anyone pretending to be a technical teacher, or, indeed, a teacher at all, to teach abstract principles and theories as such without basis upon the facts and applications from which, in the beginning, they arose. Mathematics, geometry, physics, electrical theory, are taught, we suppose, because they will be of some utility in application somewhere and somehow. We maintain, and it is a matter that is proved day after day, that all such training can be better seized by the student if grafted at once upon actualities, and useful actualities; those where the bearing of his work is known to the student beforehand, and in which he is not left to wing a limitless way among fictions and hypothetical nonenities unheard of out of a classroom. If some teachers in technical schools have partly discovered this truth, it still remains for them to wholly discover and acknowledge it. It still more rests with the other so-called science schools and colleges to change their methods of work, and bring themselves into line with the advance of educational science and the dictates of practice.

It is true that in the workshop practical matters alone are the end and aim. On the other hand, in the school quite often practical matters are banished, if not derided. Even where the reform has begun the teachers have seldom the courage of their principles, and the reform is not thorough. We do not wish college and workshop to coalesce, or that colleges should become workshops; but we do desire to see theory running on the same rails as practice, that practice should be dealt with in college—not as an end, but as a means.

Theory must be taught in schools, for this is their aim and object. But how? There may be 50 different manners of teaching theory. To be fruitful, it should be learnt by students quickly and in much the same manner as it was learnt, slowly and with pains, by the discoverers—experimentally and on actualities. To be fruitful, theory should be (in fact, can only properly be) taught by means of practice, and the more fruitfully if on the latest and very best practice. Why cannot the schools base every part of their teaching on the actualities found around the generation they teach? When taught and illustrated always on examples and for a definite end, an end always first stated and always kept in view, teachers might obtain the double advantage of giving real knowledge and of obtaining the desired training in principles at one and the same time.

Two important questions are often left out of sight in dealing with students: (1) How do the students themselves wish to learn—how *do* they learn when left alone; and (2) What is it that the practical men desire that they should learn? It is certain, in the first place, that if a student is given what he wants to know, and not what the teacher thinks he ought to want to know, that he will learn more quickly and more thoroughly; and, secondly, it is equally certain that technical teachers will be doing their duty better if they teach what future employers desire should be taught, rather than what the teachers *think* the employers desire, or ought to desire. Permanent examination questions should be appended to be asked at the end of the last course—viz.: To the student: "Have you learnt what you wanted to learn, and as well as you wanted to learn it?" and to the employer (when the student gets one): "Has your trained student been trained in the way you wish him to be trained, or in what would you suggest a difference?" Useful questions these, both of them. Tabulated and published we might see some interesting results.

The workshops cannot, except by hazard, and without order, teach theory; the facts from which theory issues are there, but the facts are not organised. A principle is that which the mind perceives from an organised collection of facts, and this it is that the college can afford time and opportunity to give. But the facts—this is the whole point—should be as near as possible exactly those that will be met with in workshop practice, not an entirely other set. For future engineers, before all others, the teaching should have, always and everywhere, a direct bearing on practice.

This is not our opinion alone, it is that of most engineers who have to deal with actual work.

"Before the question: How to become an engineer? can be fully answered," wrote Mr. Clement E. Stretton, C.E., the railway engineer, in a recent letter to a contemporary, "we must know the exact class of engineering which a young man desires to follow. The great difficulty at the present day is the difference between theory and practice. Large numbers of young men have been instructed at technical schools, etc.; they are filled with theory, but have no practical knowledge. The result is that for daily work in the shops they are useless, and cannot obtain a situation or a living. These are the young engineers who are constantly complaining that they cannot get into positions or make progress in engineering. On the other hand, the good practical man who can take a bit of work in hand and carry it through to a successful issue, is always required, and has never any trouble in obtaining a situation. In short, there can be no question that the education of an engineer will in future have to be much more practical than it has lately become."

We have had many letters fully bearing out our views that the students from many technical electrical classes too often leave with extremely little knowledge applicable outside an examination paper. It is the common complaint of the profession. There is fortunately, however, another side to the question, where students have been fairly well taught, and are found both useful and well trained. This is so, however, more particularly in the lighter and more scientific pursuits. Messrs. Swinburne and Co. and the Edison-Swan Company both bear witness to the efficacy of the training in this direction at the City Guilds' technical institutes.

Mr. A. H. Bate, of the testing department of the Edison-Swan Company, who has had many students from Finsbury, gives his views thus:

"If the training received in a technical school is to be judged only by the knowledge which the student carries away with him, I fear it will not bear comparison with the apprenticeship system. Comparatively little can be taught in any school or college which bears directly on the daily routine of factory work, no matter how able the professors or how good the methods. A general outline of all branches of the profession can be given, and a firm grasp of the main laws of physics can be obtained in a course at a college with a thoroughness which is impossible in a factory. An instinctive appreciation of Ohm's law is of infinitely more value than an accumulation of magnetisation and dynamo formulæ; for however much the students may like this sort of thing, not one in ten of them will ever design a dynamo, and for those who do the required information can be obtained from books. The value of such teaching lies in the mental training which it gives.

"The power to deduce these facts from first principles is worth infinitely more to a man than any fact or set of facts. There are too many men about who know but cannot think, and as far as my experience goes technical education is valuable because it provides the mental tools and teaches how to use them. Although a young man who has just come from a course at a college is not of much immediate value in the works, he soon overtakes the most accomplished 'penny-in-the-slotter,' and as he gains in experience his knowledge is orderly and systematic. There are some men who have such a distinct genius for correct reasoning that they do not need any special training to teach them how to get the truth from experimental evidence, but these are the exceptions. For most of us the technical college does not stand as a substitute for workshop training, but as a valuable supplement to school education."

We make the following exception from Mr. Bate's statement that "the power to deduce facts from first principles is worth infinitely more than any fact or set of facts"—namely, that exactly a first principle is obtained from "a set of facts"; and properly seen and studied, the "set of facts" will give the man just that appreciation of a principle which the mere statement of this principle can never give—a psychological truth which teachers often forget, even if they recognise.

We have applied to Mr. Jas. Swinburne for his views on the subject of training electrical engineers, knowing that he has had favourable experience of electrical students. The following is the outcome of our request for his experience and ideas:

"In answer to your enquiry as to my experience of electricians trained at technical colleges, I can only say it has been most satisfactory. Most of our work is of a semi-scientific nature, and whenever we want a good man we write to Prof. Thompson or Prof. Ayrton, and so far we have always got what we asked for. The qualifications I look to are mathematics, the theory of electricity, and chemistry in some cases; and we do not care about proficiency in such matters as dynamo or transformer design. In many cases a previous training in experimental work is of the highest value to us. Our business is, as I have already stated, somewhat special, but we would certainly entrust almost any work in the hands of many of the men who have come to us from these two technical colleges.

"I cannot help feeling, however, that the colleges make a mistake in trying to teach practical engineering. Such things can be better learned at a works afterwards. It is quite impossible for science teachers to be well up in machine design as carried on in practice—that is to say, in relation to shop cost—and it is useless to teach text-book engineering. If a man comes who has been taught that a dynamo is designed so that the magnetic resistance of the clearance is half the resistance of the whole magnetic circuit; or if he talks of critical speeds of dynamos, or the self-induction of a transformer, he finds he has to change his point of view before he can come into touch with real work. I suggest, therefore, that it would be better for the colleges to teach pure mathematics—the more the better—chemistry, and physics, with a special course of the theory of electricity and machine drawing. The fundamental principles of dynamo machinery, and so on, should, of course, be taught.

"On the other hand, business firms are worse than colleges. The premium-pupil system is in want of much more thorough revision. We make a point of allowing both pupils and apprentices to leave their work to attend lectures, as we believe that is of the highest importance both to them and to ourselves. Still, I cannot help feeling that whatever faults we can find with the colleges, we manufacturing electricians should look into our own systems first. For my own part, I served a long apprenticeship as a mechanical engineer, and never attended lectures after leaving school at 16; and I very much regret it, and would like to see others saved the uphill work of reading mathematics and science at odd times alone."

It is pleasant to be able to give this testimony to the value of the technical training at the City Guilds' Colleges. At the same time, the feeling that engineering is badly taught peeps through Mr. Swinburne's very interesting remarks. The colleges, he thinks, make a mistake in trying to teach engineering. They do so, we think, because they do not base their teaching on what is done in real life. "It is impossible," he goes on, "for science teachers to be well up in machine design as carried on in practice." Impossible! Why impossible? What a reflection on teachers of engineering—their teaching is useless, they do not keep up with the practical men. Just so: but it is not "impossible." The words "It is impossible," on the contrary, should be "It is absolute necessary." Suppose, if the professors cannot do so, there were a functionary whose duty it was to find out what were the principles and practice in real engineering up to date in the best shops, who would keep the professors informed thereof. Would this be useful to their students or no? Could the principles be taught thereon or not? Mr. Swinburne goes on: "It is useless to teach text-book engineering." Think of this, ye who are teaching "text-book engineering"! The deliberate opinion of an engineer is that it is useless. Are you content that it should be useless: can it be made useful? These are momentous questions. And the writers of these useless text-books, can they mend their ways? If we could have facts, present-day practical facts, carefully and thoughtfully organised, as a basis, perhaps the teaching would not so often have cast in its face that it was "useless."

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 400.)

Notes on Running.—The weakest part of a dynamo, and the only one that really requires any watching, is the commutator and its attendant brushes. The field magnets, being built of solid slabs of iron, suffer no depreciation, and will last until the machine is obsolete. Almost as much can be said for the coils they carry, since they are stationary, and not subjected to any strain. With machines that are not of sound workmanship, the insulation will become defective, but this is not a serious matter, and can be repaired by the dynamo attendant. Should a short circuit occur, however, and burn or otherwise damage the inside coils, then it is a long and troublesome task to unwind, repair, and rewind, but excepting an unusual case of this sort there is little or nothing to disturb their life and soundness.

Turning our attention to the armature, this is much more liable to accidents and damage. When a dynamo gets short-circuited, the armature may get burnt up. The damage done varies: sometimes the armature is completely ruined, at other times it is one or more coils that are damaged, when they must be taken out and repaired, or replaced. Another source of weakness is the binding wire of the armature. This is liable to break or get torn off to the extent of two or three turns.

Foremost in point of vulnerability comes the commutator, which, as before mentioned, is the weakest part, and it is the only part subjected to wear and tear. Here, the brushes are constantly rubbing and wearing, and this, together with a more or less amount of sparking, will very rapidly make its effect apparent, unless great care and attention is exercised. A dynamo attendant takes as much pride in the condition of the commutator and the brushes as an engine-driver does in the smooth running of his engine; and so he ought to, since it is the only part of the dynamo that requires any attention. A well cared for and preserved commutator presents a highly burnished darkened appearance, is perfectly true and smooth, and has no scoring on it. The state of the commutator depends almost entirely on the state of the brushes and the way in which these latter are adjusted.

Dynamo brushes are of various types. The most common form in use for incandescent dynamos, with the closed-coil armature, is that known as a gauze brush; this brush is made up of a length of copper gauze folded round several times, so as to make a solid thick strip, about three times as long as it is broad, and from ¼in. to ½in. thick, the size of the brush being increased as the machine becomes larger. This kind of brush being of a soft and yielding nature, makes a springy contact on the commutator, and so avoids cutting or scoring, but against this there is the disadvantage of the brush wearing more quickly. Commutators are made of hard rolled copper, gunmetal, or phosphor bronze, but it is naturally better to have the brushes wear than the commutator, for the former can be easily and cheaply replaced while the latter cannot. Another good kind of brush, very suitable for small dynamos, is formed by a number of thin brass strips lying one on top of the other, each strip being cut, say, $\frac{1}{16}$in. shorter than the one on top of it; being very flexible, the several ends make contact on the commutator when the brush is placed flat or tangentially on the surface. Brass being harder than copper gauze, does not wear so quickly. The great advantage of a brass-strip brush is that the trimming is next to nothing. Every three or four days—according to the number of hours the machine works—the tips feather out, and all that is necessary is to clip the tips off by a pair of shears, or strong scissors, and then push the brushes forward a trifle in the brush-holders, when replacing them, so as to ensure their occupying the same position. Another advantage of this kind is that they can be home-made, and at a very small expense; when the various strips are cut of a suitable length and width, the bottom ½in. must be well soldered, in order to hold the strips together. Prior to the gauze brush the most common form was a bundle of fine copper wire, one end being soldered, while a metal band was slipped over the other end to keep the wires in place, the dimensions being similar to the gauze brush, but it cuts the commutator more than the gauze does, and is more troublesome to trim.

For arc lamp dynamos it is usual to use a brush made of a fairly stout strip of brass, about one-sixteenth of an inch thick, and, say, 8in. long, the width being from 2in. to 3in., according to the size of the machine. One end of this strip is split into about five or six tongues, extending a suitable way along the length, and the split end being thus made flexible, presses on the commutator. For alternate-current machines, light gauze brushes are the best, the current being only small.

Carbon brushes are found to be of great service when the load on a dynamo varies greatly, because with a fluctuating load sparking is very prevalent, and carbon reduces this to a great extent; for this reason, they are particularly suitable for motors, and in America scarcely any other kind are used for traction work. They are fixed "butt" end on the commutator, because a motor armature is required to revolve in either direction, and the holder is fixed quite close to the commutator in order to form a support to the brush end, carbon being somewhat brittle. For equal section they will not carry so much current as metal will, therefore 50 per cent. more cross-section should be allowed; having them copper plated gives a better electrical contact.

We have stated what the appearance of a well-preserved commutator is like, and will follow this up by giving hints and advice how to keep it in that state. The effect of a brush pressing and rubbing on a commutator tends to produce a hollow along its path. This hollow is produced by three main causes—first, length of time; second, pressure of the brush; third, hardness of the brush. Then there is the detrimental effect of sparking, which burns away the segments and the brushes.

However well the brushes are adjusted, the constant friction of the brush is bound in time to wear away a groove. The result is that between each brush there appears a slight ridge. These hollow ridges can be felt before they are seen by passing the finger lightly across the commutator. The merest indication of a ridge or path should be promptly combated, by treating them with emery-paper. If they are allowed to increase, then emery-paper will no longer be of use, and a file must be put on, and if neglected beyond this the hollows will develop into "ruts," and nothing short of having the commutator returned will make a good job of it. The evil of these hollowed paths is that the brushes are worn unevenly, and cannot be adjusted; result is great sparking, and this, with the bad state of the brush, increases the bad state of the commutator, and *vice versâ*. But since "prevention is better than cure," means should be taken to prevent even the smallest ridging, and the only way to do this is to set the brushes in such a position that the positive ones lie on the commutator, covering the gaps between the negative ones. A brushholder being, say, ¼in. to ½in. wider than the brush it carries, there is an equal gap between the brushes when two holders are set close together; with this arrangement, all the surface of the commutator between the two outside brushes gets equally worn. A great fault of some commutators is that they are too short to permit of this, there being just room to take in the set when placed exactly opposite each other, and no more, or at the most not enough to be of any use.

We now reach the second cause—viz., pressure of the brush. This does not as a rule receive the attention it should do, particularly when dynamos are to a great degree left to run themselves, as is often the case in mills and factories; or else are looked after by those who know very little about them. The tension of the springs should be just sufficient to cause the brushes to make a light, yet reliable contact with the commutator. The contact must not be too light, because the brushes will vibrate and so cause sparking, and if they press too hard they will wear away both themselves and the commutator to an undesirable extent, and in addition will become unduly heated owing to the great friction. The best proof of the grinding pressure of a brush is the amount of brass or copper dust thrown off: the upper side of the negative or bottom brushes will become covered with this dust, same with the holders; the dust will also spread about and cover an inch or two of the cables leading from the brush-carrying bar. The tension of the springs of the bottom brushes should be made slightly greater than that of the top brushes on account of the weight of the former. An idea of the proper pressure can be obtained when the brushes can be pushed off the commutator by the little finger with ease.

Reaching the third cause, that of hardness of brushes, it is evident that a brass-strip brush will wear away the commutator more than a soft copper-gauze brush will do; something must wear, in the former case it is the commutator, in the latter case it is brushes, so that the harder the brushes are, the less should the tension of their springs be, if this is possible. To prevent cutting of the commutator by these hard brushes a lubricating matter is often put on the commutator—the best vasoline is the only lubricant that should be used; when used, only the very smallest amount should be smeared on a finger tip, and then applied by passing the finger across the commutator. It reduces wear and tear, but the writer prefers to run commutators dry; it is the safer plan. Some people smother their commutator in bearing oil; result is the brushes get clogged up with carbonised oil and dirt, and trouble is sure to follow such practices, for this matter forms a film over the segments and tends to short circuit the armature coils.

This last objection does not apply to alternate-current machinery, nor to arc light dynamos, because the first have ring collectors instead of commutators, and the brush never breaks contact, and the second have air-gaps between the segments. The whole of the brush-carrying gear should be kept scrupulously clean, and once every week or so, according to the number of running hours, the gear should be taken entirely to pieces, by taking off the carrying bars, and cleaning the holder parts, spring action, etc. Very often the carrying bar will be partly covered by a thin black film of oil and dirt, thus obstructing proper electrical contact between the holders and the bar. This and another point to which particular attention is drawn, is that the insulating ebonite or vulcanite washers which insulate the carrying bar from the rocker, should be well cleaned. Through being near the driving-shaft bearing, oil sometimes gets thrown off and may settle in a very fine film over the surface of the rocker, and also over the insulating washers, the proof of which is that these become sticky; and should the washers get sprinkled over with copper dust thrown off by the brushes, a film of oil and dust is formed having the property of a partial conductor. These washers are only about ⅛in. thick, and are all that insulate the positive brush from the negative, for the rocker is made of iron, and if the insulating qualities of the washers deteriorate or break down, there is a dead short circuit of the armature.

The most suitable angle at which gauze or wire brushes should make contact with the commutator is 45deg., and all these kinds of brushes are therefore shaped to this angle at their contact end. The tip of the back of the brush is called the "toe," and the beginning of the angular contact face at the front of the brush is called the "heel."

(To be continued.)

THE "GENERAL" METER.

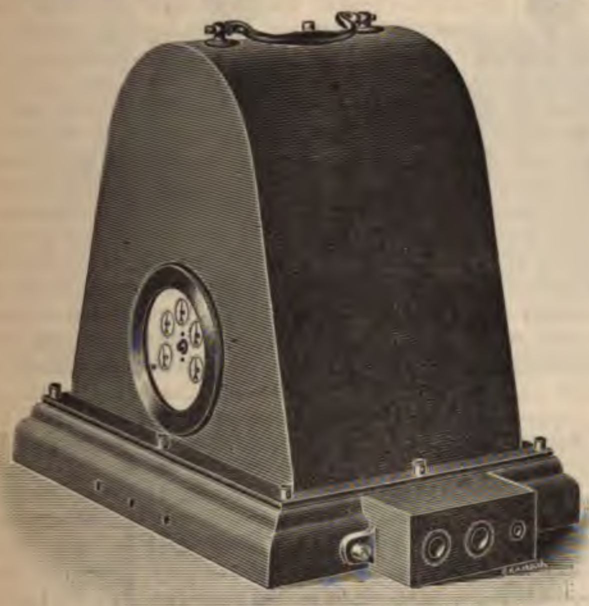

FIG. 1.—Meter, with Cover.

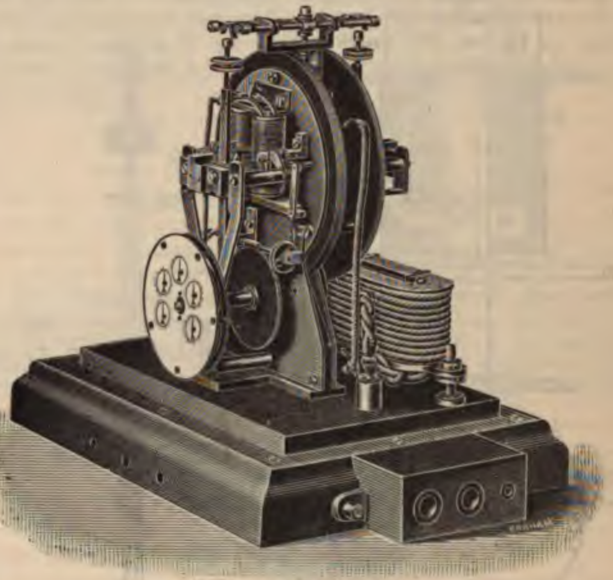

FIG. 2.—Meter, without Cover.

The principle of the "General" meter, Figs. 1 and 2, now being introduced by the General Electric Company, briefly stated, is that of a magnetic field upon a swinging magnet. When a magnet is vibrated under the influence of gravity alone it is virtually a pendulum, and as such will make a definite number of beats per second. If it is vibrated within a magnetic field so that such a field exerts a pull upon it, it will vibrate much quicker, as the effect is to augment that of gravity, and the number of these vibrations is in exact proportion to the strength of current exciting that field. If, however, the field exerts a repelling action, the effect is to counteract gravity, and the pendulum vibrations are retarded, and the retardations are also proportionate to the current. By the employment of this principle it is possible to obtain wide and very accurate registration of range of current; from half ampere to 1,000 amperes, for instance, can be readily registered. In order to obtain the registration two clocks are used, one having an ordinary pendulum, the other a magnetic one, adjusted so that ordinarily they swing in unison, but should the magnetic one be subjected to the influence of a magnetic field its rate is accelerated, and the difference between the rate of the accelerated and the ordinary pendulum is, by suitable converting gear, duly registered. This principle has been employed by Profs. Ayrton and Perry, and also by Dr. Aron, in the meters constructed by them. The clockwork in these meters requires winding, and periodical attention is therefore necessary. The "General" meter differs from these in this respect, that the necessary force for keeping the meter running is derived entirely from the source of supply. The pendulums, which may be described simply as vibrating bars, are kept swinging by small gravity impulse weights, which at each complete swing are caused to fall with the pendulums a short distance, and these weights and the distance through which they fall being constant, it follows that the vibrating bars are actuated by a constant force, so that although the E.M.F. of the supply vary, the rate of the vibrations of the bars is not thereby affected. The coils of the electromagnets, which are employed to lift the impulse weight actuating the bars in the "General" meter, are joined up with suitable high-resistance coils, and are connected, in short, across the supply leads. The total resistance of the coils of each clock being 6,000 ohms, the current necessary to drive each clock is only one-sixtieth ampere, and this is only required during less than one-half of the swing—and during the time only while the light is used; the cost for driving need not be considered. By a special arrangement of the winding of these coils sparking at the contacts is suppressed. The current to be measured passes through a solenoid of special shape, the resistance of which is extremely low, placed immediately below the magnet bar, and which it influences, as stated before. The lower pole of the solenoid acts upon a light pivoted magnetic needle, so that directly a current passes through the turns of the solenoid the needle is deflected, and by that means the contact is made which closes the short circuit of the electromagnets' coils, and both clocks immediately start working. A current considerably less than required for one lamp is sufficient to deflect the needle and so start the clocks, which cease to register when the current is switched off. The same electromagnets which lift the gravity impulse weights also actuates the recording gear, each lift of the armature moving through a suitable wheel in the main axles of the recording apparatus. The axle of one clock being hollow, allows the axle of the other clock to be brought through it. The hollow axle carries a frame and dial, which revolve together, and the other axle carrying the wheel, which gears into one in the frame, does not move from its position. When, however, one axle is moving faster than the other, the difference is indicated by a pointer, and it is evident that by suitable arrangements of counting gear the registration of the difference in the number of revolutions made by the axle in any given time is simply and easily effected. We may state that the "General" meter has been designed to fulfil the Board of Trade requirements in every detail, and after the meter has been calibrated and tested the cover can be securely fixed in an airtight manner, and the securing screws sealed. The terminals, which are outside the meter, are protected by a cover, which the fitter can remove when connecting up, and after he has replaced it this can also be sealed. In order to protect the pendulum from injury during transport, a clamping arrangement is provided which can be manipulated without removing the cover.

Description of Working Parts and Connections of the "General" Meter.—The electromagnet driving apparatus and the vibrating bar of one side of the meter are shown in Figs. 3 and 4, the former being front view of the bar, the latter a side view showing the suspension springs. Fig. 5 is a sketch (diagrammatic) of the whole meter. When a current passes through the main coil consequent upon switching on the lamps, the magnetic relay needle is deflected, closing the contacts and putting the contact screws in connection with the shunt circuit for drawing the clocks, by being in connection with the frames of the clocks. As both clocks are electrically joined up alike, it will only be necessary to follow from one of these screws the course of the current. The pendulum bar, K, is insulated from the frame and connected to one end of the coil, C, the other end of the coils being connected through a suitable resistance to the return lead, so that the pendulum cross-piece, R, being in contact with the contact screws, S, the coils are energised, and the armature, D, is raised, and consequently the lifting-pin, H, on the end of the lever, E, is depressed, and the full weight of the gravity-piece, J, then acts upon the bar, K, through the cross-piece, R, starting it into vibration. When the end of the gravity-piece, J, strikes the stop, T, the bar continuing its forward swing causes contact between screws, S, and cross-piece, R, to be broken, and the armature, D, immediately falling and acting on the lever, E, through the link, G, makes the lifting-pin, H, raise the gravity-piece, J, the position to which it is lifted being determined by the stop screw W. When the bar swings back the circuit is again completed through contact screw, S, with cross-piece, R, and the cycle of operations is regularly repeated during the time the magnetic relay needle is deflected by the current passing through the main coil. The impulse necessary to maintain the vibrations of the bar, K, is obtained from the falling of the gravity-piece, J, falling from the definite position of the lifting-pin, H, to that of the stop screw T, and is independent of variations within a wide range of the driving current due to fluctuations of the voltage on the supply mains. Besides lifting the gravity-piece, the armature also actuates the pawl or pullet connected with the registering gear, as indicated in the sketch, so that for every complete swing of the pendulum bar a tooth in the wheel is moved forwards, and that swing registered.

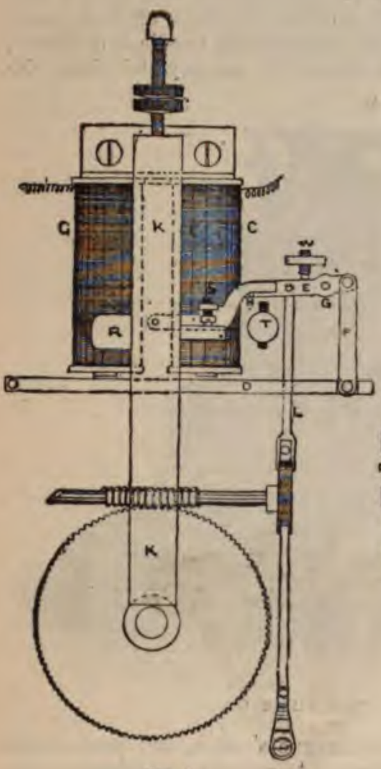

FIG. 3.

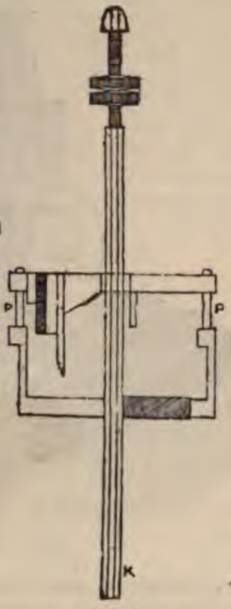

FIG. 4.

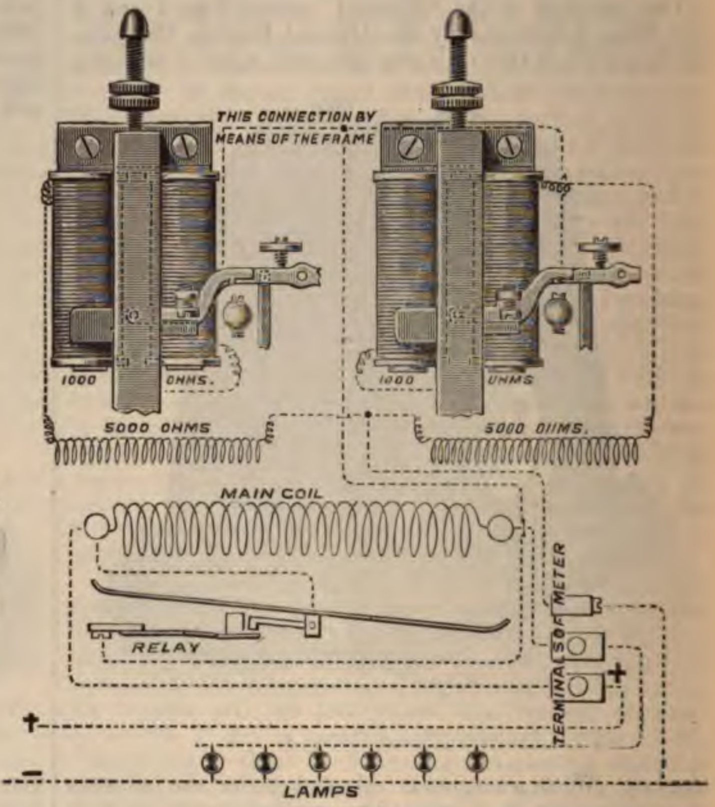

FIG. 5.

PRACTICAL ELECTRICAL PROBLEMS AT CHICAGO.*

BY PROF. SILVANUS P. THOMPSON, D.S.C., F.R.S.

It is not the object of this paper to traverse beforehand the topics which are to be submitted to discussion at the Electrical Congress to be held at Chicago three months hence. The opinion of that congress is to be taken upon certain matters of utmost importance—such as the final adoption of international units and standards, as well as other questions of nomenclature which are of international convenience. To attempt to forestall the decision of the congress on these or other matters by raising a discussion on them here would be both ill-timed and discourteous. My object is entirely other. It is, in brief, to draw your attention to a number of matters which are at present engaging the notice of electricians, matters which are, for the most part, on the verge of scientific progress, matters partly within and partly without the range of the practical electrician. From that border-region, just outside the limit of actual commercial practice, must inevitably come the next advances in the industry. Everyone who is familiar with history of inventions knows how it is that, before any great world-compelling invention takes practical form and shape, it is more or less consciously existent; it is "in the air"; the pioneers are alive to its possibilities, though they may be accounted but as dreams of the unpractical. Discovery of the abstract order—often unrecognised as to its importance, yet none the less pregnant of result—almost invariably precedes invention. The task of reducing to serviceable form, fit for use, the newly-discovered abstract truths is the problem before the inventor, who, indeed, may be both discoverer and inventor in one, the pioneer both in science and in industry. Of late there has been a lull in electrical invention. Not that the footsteps of inventors have ceased to dog the Patent Office, or that the streams of outflowing specifications have been dried up. It is the quality, rather than the quantity, of recent electrical inventions that has declined. Those eventful years, from 1873 to 1883, which may be said almost to have created the modern electrical industry, saw the introduction of many radically new inventions, many really novel departures in the application of science; and the very fertility of that harvest of invention seems to have, for a time, exhausted the soil.

But the apparent pause in the progress of events is the real time for the progress of ideas—the epoch for the incubation of new suggestions. Once the new ideas have taken form and growth, the development from them of new inventions is a logical certainty. The new inventions must and will come. We seem now to be approaching the close of the period of lull; and the new ideas that have been gradually spreading and rooting may be expected to crop up in invention. We seem to be treading on the verge of new methods, new appliances, new results.

At such a time, as circumstances have decreed, we are to meet our electrical brethren, not only of the United States—that home of free ideas and unbiassed progressiveness—but also of other countries, in friendly converse as to the progress of that art and science in which we are most interested. We shall rub shoulders and exchange views and opinions with them; discuss our special varieties of practice, our special points of experience, our expectations, and hopes and doubts. We shall have much to learn from one another; and in the amicable rivalry of nations, we shall all be keen to make the most of our opportunities.

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* Paper read at the Society of Arts on May 3.

What, then, are the points that will interest us most? What are the burning questions that will awaken our attention? Let us begin with some more sternly practical questions that confront the electrical engineer. The methods of working that prevail between different nations in the matter of electric light and power present many points of divergence. One cannot help raising the enquiry why these divergences exist, and whether amongst them there is not a best way to be chosen? Let us consider them in detail.

Not only do we find divergences in the types of generating plant in habitual use in central stations, we find differences in the modes of distribution, even in the methods of house-wiring, differences which are not mere matters of taste or fashion. In the average English central station the dynamos are few and massive, and, for the most part, are mounted so as to be direct driven each by its own separate high-speed engine. Belting and countershafts are conspicuously absent. In the average German central station, though both engines and dynamos differ in type from the English, direct driving is almost universal. The main difference, as between British and German practice, is, that in England, where land is dear, we build compact high-speed dynamos, and design special engines to suit them; whilst in Germany, where compactness is no great advantage, large slow-speed multipolar dynamos are designed to suit the large slow-speed engines. Contrast with this the average American lighting station. The dynamos are not designed for the engines, nor the engines for the dynamos, and neither of them is specially designed for the particular station where it is to be erected. Both of them are, so to speak, taken from the stock of some particular factory; and as the dynamos are comparatively small, numerous, and high speed, whilst the engines are few, large, and of slow speed, engines and dynamos cannot be coupled direct, but must be geared by the intervention of countershafts, pulleys, and belting. Not that there are some fine exceptions; for example, the Elm-place Edison station in New York, the machinery of which was designed by Mr. Van Vleet, after a tour of inspection in Europe; but for the most part, leather belting is the one conspicuous feature of an American lighting station. Take, for example, that of St. Louis, Missouri, the largest arc-lighting station in the world. The engines are on the ground floor. The dynamos, 65 in number, are on the second floor. The whole of the first floor of the building is given up to a magnificent array of long countershafts, carrying some 70 pulleys and leather belts, receiving power from below, and transmitting it to the floor above. Our cousins evidently believe in the duties of leather. We have absolutely nothing to show like this on our side; the nearest approach being the Westinghouse station of the Metropolitan Company at Sardinia-street.

That it may not be said that I am giving as an example an old station built in 1891, let me set alongside the St. Louis example the very latest one that came to hand but two days ago in the *Electrical World* (New York) of April 22, 1893. Therein is described the new central station of the city of Akron. Compare this with such stations as our Manchester-square, or the St. Pancras, or the stations of the Westminster Company, or of the Kensington and Knightsbridge Company, or those of the St. James's Company. In none of these is there any countershafting or belting. Nor is there in the new Glasgow station. Nor will there be in the new machines of the City of London Electric Lighting Company, at Bankside, though, in the temporary and transition plant, rope-driving without countershafts has been employed. Not that I would dispute that there are advantages in driving by the aid of belts. The method has the obvious advantage that, if a bad short-circuit occur, the belt is thrown off or broken before any other damage is done. In other words, it prevents armatures which are of inferior mechanical construction from being destroyed by an accident which ought to have been entirely impossible of occurrence.

Not only in the matter of direct driving, but in the whole design and construction of station switchboards, does practice diverge. The British engineer desires to have everything as solidly simple as possible. His ideal is simply a pair of omnibus bars, into which all the dynamos feed in parallel, and from which all the feeder mains run off to the various circuits of the distribution. He does not in all cases attain to this sweet simplicity, especially in those stations where a battery of accumulators is used, but that is what he desires to attain to. The American switchboard evinces an almost equally strongly marked ideal, the desire being to divide up the circuits and the generators into as many separate units as possible, while retaining the possibility of connecting up any one of the dynamos singly with any one of the separate circuits. The most recent and elaborate of such switchboards, resembling in the quantuplicity of its parts the multiple switchboard of a telephone exchange, is figured in the supplementary issue of the *Electrical Review* (New York) for February 25, 1893. It is the switchboard specially designed for the Manhattan lighting station, and is so contrived that with 17 circuits and 19 dynamos, by no possibility can any two of the dynamos be put into parallel with one another.

Practice differs again in the mode of distribution by mains. An electric light pole, and having a transformer hung on to it, where it brings the current to your house, is a sight which cannot be seen in England, simply because it does not exist. Our transformers are almost always put in fireproof cellars, and our mains run underground in conduits instead of overhead on poles.

In house-wiring, too, practice differs. The wooden casing that, thanks to the fire office rules, is almost universal in England, is by no means universal elsewhere, and in some countries is almost unknown. It is probably destined to disappear in time, when safer modes of carrying wires are recognised. Wood casing has three grave defects– it is neither damp-proof nor incombustible, and, too often, it covers, like charity, a multitude of sins. In this connection it is important to note that, in spite of the curious prejudice of so many of our fire offices towards the use of wooden casing, the proportion of electrically-caused fires in this country is extremely low. This satisfactory circumstance must be attributed, not to the general use of wood casing of house wires, but rather to the very wholesome dread inspired by the vigilant and able surveyors of the chief fire offices, of whom Mr. Musgrave Heaphy is the most eminent, and who have, in spite of the curses so frequently showered upon their heads, insisted upon the prime requisites of good material and sound workmanship in all risks that they undertake to insure. If their requirement have seemed, in individual cases, hard or arbitrary, they have done incalculable good in stamping out the inferior work of scamping contractors. It is an open secret that some of the New York fire offices have become of late very uneasy about the increasing prevalence of electrically-caused fires. It is even stated, though I cannot name my authority for the information, that some of them have recently sent representatives to this country to learn how we manage to keep electric lighting safe. Doubtless we shall, at Chicago, discuss opinions on many of the details of this highly practical question. What is wanted is a mode of running the wires and fixing the switches and other accessories that shall not only be electric-tight, but shall also be watertight, gastight, airtight, oiltight, and rat-tight.

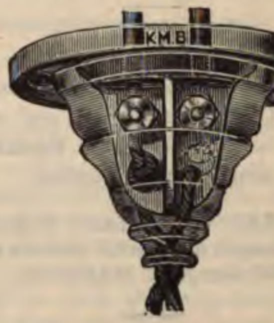
Upon the question of the degree of incandescence at which it is most economical to run incandescent lamps, we shall probably find differences of opinion. It is obvious that the "smashing point" at which it pays to destroy old lamps depends upon the market price of lamps—a factor of the problem which is just now of a very uncertain nature. Whether Mr. Westinghouse's "stopper" lamp is made a commercial success or not, it is clear we are on the eve of a great revolution in the price of lamps. When they are really cheap, we shall give them short lives and merry ones, working them while they last at a higher degree of brightness, and therefore of efficiency.

(To be continued.)

TRADE NOTES AND NOVELTIES.

A "PERFECT" CEILING ROSE.

We illustrate below a new ceiling rose which has been designed by Messrs. King, Mendham, and Co., Bristol and London, which they claim to be the best electric light ceiling fitting yet introduced. It is made of china and consists of two parts, the plug and its cover, the latter constituting cover and base combined. The plug is divided into four parts by webs, and the terminals are fixed through these webs, as shown in the illustration; an additional terminal is provided to carry the fuse. In wiring, the flexible cord is threaded through holes and knotted before being attached to the proper terminals, and the branch wires are brought through holes in the base of the plug. The advantages which Messrs. King, Mendham, and Co. claim for this form of fitting are, in the first place, in fixing: the terminals are right in front of the wirer, so that he has not to work up against the ceiling, as he has when fixing the ordinary form, except when he is securing the cover to the block by the three screws. Secondly, a knot in the twisted cord is not required, which has hitherto been a very bad feature in these fittings: in wiring the plug of these fittings the knot is tied in each single-stranded cord, and this knot relieves the terminals of the weight of the lamp and shade. There is no thread on these fittings to strip, and as the plug fits loosely into the cover, these parts are interchangeable and can be used promiscuously. From the design of the plug, with its webs, the fitting has a very high insulation, and no short circuit can possibly occur from stray strands. The ceiling rose is therefore suitable for systems of any high voltage and for any positions. Further, from the shape of the cover the fitting lends itself admirably to decoration. Lastly, the simple design of the two parts, and the absence of a thread to cut, render it very easy of production, so that it can be sold cheaply.



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MUNICIPAL ELECTRICAL ENGINEERS.

The future of electrical engineering will be largely in the hands of those who serve municipalities. This class of electrical engineers will be a most independent body of men—fearless of the frowns of either manufacturers or wiring and fitting firms. It will be theirs to say, and others to do. From their ranks, no doubt, in the long run will the ranks of consulting engineers be recruited, and hence in our estimation these municipal electrical engineers will form the backbone of the industry, and while united in counsel will be all-powerful. It may be thought very early in the history of electrical engineering to talk about such things, but it is better to look ahead than to look behind. We should advise all electrical engineers in the employ of municipalities and local authorities to at once organise, to form an association of themselves, to consider their own positions and the connection they have with their councils, the public, and the industry at large. They have disabilities which do not come under the cognisance of the Institution, they have business relations as well as scientific relations with the various bodies we have mentioned. They have now the chance of fashioning and consolidating these relations, and marking out the lines upon which municipal electrical engineers should travel. The positions held by such men will ultimately be among the best at the command of the profession, and should be filled with the best and ablest men. The municipal and county engineers have an association second to none in importance from the general point of view, but the work of the electrical engineer is neither so wide nor so important, if we may be forgiven saying so, as that of the municipal engineer; is clearly of a different type, and therefore requires a separate organisation. There are many delicate questions to be settled. What is to be the exact position of the municipal electrical engineer in the local constituency? Is he to be separate or connected with the engineer of the authority—a kind of special assistant, or an independent authority, reporting direct to or receiving orders direct from the lighting committee? These and scores of red-tape questions will be more easily settled now than hereafter. They will not, however, be settled satisfactorily unless the electrical engineers are agreed together as to the position they require to take. We are not quite sure that the electrical engineers in charge of central stations which belong to companies have much in common with the municipal electrical engineers. They must, from the nature of things, be a less independent body, and, in fact, in many instances have little real authority. They will probably be always on the look out to leave a company's service for service with a corporate body, hence in no small measure will be interested in all the concerns of the municipal electrical engineers. When such towns as Bradford, Brighton, Blackpool, Hull, Nelson, Manchester, Taunton, Dundee, Glasgow, Galway, Londonderry, etc., have their electrical engineers—and it is quite certain many other towns will quickly follow suit—the importance of the position is at once seen. The analogous positions are those of gas managers and waterworks managers. At any rate, we have thrown out a suggestion which those interested can examine and act upon if it meets their favourable opinions.

THE TELEPHONE QUESTION.

We are aweary, and trust that this controversy may soon be brought to a conclusion. Our contemporary, with conspicuous ability, refuses to come to close quarters, or to prove its assertions. The origin of this controversy must not be forgotten. It arose from a sweeping condemnation of the New Telephone Company as having suggested nothing new—only that which had "been tried and failed." Long since the condemnation has been quietly shelved—or perhaps it will be said has been justified by the reiteration that the Mann system is not the Mann system: it is the Law system, and as such is old, has been tried and failed. But the term "failed" has, we think, been proved incorrect. It could hardly have been otherwise, because it has been shown that the Mann system has been introduced, and successfully so, in quite a number of places; it has for satisfactory reasons been abandoned in some places, but never because it "failed." We are now referred to the one original point—it is old, with a new proviso that hitherto only principles were considered, not details. As a matter of fact, however, our argument against the contention "old and failed" has not reduced the matter to one of detail. With us it was always a matter of detail. Long ago we said Shaw might have indicated the way, and no one would withhold credit for so doing, but indicating and practically carrying out are two different things. We did not, though we might have done, dispute the evidence produced, which really has little bearing on the value of Mann's work, and the recommendation of the New Telephone Company. Our reasons for saying this are purely theoretical—internal evidence of writing; external evidence in other directions goes to show that neither Mann, nor Miller, nor Maier, nor Bennett, nor Preece, nor Allsop, nor Poole, nor any other speaker, nor writer, nor inventor outside the office of our contemporary had seen or heard of this pamphlet which says so much and was so remarkably little known. The Law Company did not embody this knowledge of principles and details in any patent specification taken out here. We have not been told that any patent embodying the principle was taken out even in America. Our contemporary says: "All our remarks were based on a circuit wire system as such without reference to any details of construction or methods of working." Surely this is insufficient upon which to condemn active workers. Faraday gave us the principle of the dynamo, but because the principle is embodied in his researches, are we to give no honour or credit to Siemens, Pacinotti, Gramme, and others who have worked out the details and made the machine practicable? Because Reis did something to obtain and give effect to the principle of the telephone, is no credit due to Bell and Hughes, whose work made the apparatus practical? Bakewell gave us the principle of the copying telegraph: is there no credit due to Elisha Gray for his telautograph? We contend now, as we have done before, that often, in applied work, at least, two people deserve honour—the one who points out the principle, and the one who practically applies it. We are willing to give Shaw or the Law Company credit for the principle indicated in this pamphlet. Our contemporary says plainly that it has been tried and failed, but we say, only tried and failed in the hands of the Law Company. Mann came along, and whether he knew aught of Shaw's work or not matters little. What Mann superintended has not failed, but has succeeded. The New Telephone Company has advocated, among other things, the system that succeeded at Dundee and elsewhere, and so cannot in this particular case be said to have advocated something old that had been tried and failed. We do not want to detract from any credit due to Shaw; we do want to give credit to others who succeeded when his own company failed. To put this point in another way: our kindly antagonist would say a boy who made a kite that would not fly deserved all the credit; while he who came along and modified, somehow or other, so as to make the kite fly, deserved no credit. That is, the Law Company tried and failed; Mann tried and succeeded. Is there no distinction? We only want to give credit where credit is due, and so far as we are concerned the question has been reduced to a nutshell. Will our contemporary give a list of places (1) where the Law system has been tried and failed, (2) where Law tried and succeeded, (3) where the Mann modification has been tried and failed, (4) where Mann has tried and succeeded; and will they admit that if Law met with no success, while Mann met with success, there must be a difference, and credit is due to someone for the success?

OBITUARY.

THE LATE WALTER T. GLOVER.

We regret to announce the death of Mr. Walter T. Glover, which occurred on the 27th ult., at the early age of 46 years. Mr. Glover was born in Salford in 1846, and was engaged early in business in the Manchester trade, in which he was for some time very successful; but on the death of his father he took the wire-covering business in hand, and being assisted technically by an excellent staff, rapidly developed it until it became the well-known manufacturing business of Walter T. Glover and Co., electrical wire and cable makers, occupying several works in Salford, and employing now a large number of hands. The firm were and are contractors to the Post Office and various departments of the Government, the several telephone companies, the railway companies, and the principal electric lighting companies. About five years ago Mr. Henry Edmunds joined Mr. Glover as partner, and the management during Mr. Glover's enforced absence for the past two years through illness have been entirely in Mr. Edmunds's hands, assisted by the old management at Manchester. During this time very great development and strides have been made in the business. Mr. Glover was a member of the Institution of Electrical Engineers, and was usually to be found at all scientific and social gatherings connected with the profession, where he was always a welcome member. He died just two years after his wife, and leaves three children.

The late Walter T. Glover was sympathetic in all that concerned the welfare of his kind, genial in his private relations, and energetic in business matters. His illness came as a shock to many of us, and for long we hoped almost against hope for his recovery. It was not to be, and at an early age we have lost one who took a very active interest in all electrical concerns, and in his business relations aimed at keeping well abreast of the times.

We understand that Mr. Edmunds, the surviving partner, will, assisted by the present experienced staff, continue the business as heretofore.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

NOTES ON ELECTRO-TANNING.

SIR,—The paper recently read before the Institution of Electrical Engineers, London, by Mr. Falkenstein, and published in your issue of April 7th, gives some additional proofs to the important part which electricity takes in the acceleration of the tanning process.

The experiments seem to have been carried out in the laboratory only, on a very small scale, and with a "carefully filtered solution of tannic acid, using platinum electrodes"—that is to say, with a tanning liquor and electrodes, which in reality are never used in carrying out the tanning process, and which, therefore, will very materially diminish the practical value of the results thus obtained.

To those who are more closely connected with electro-tanning it will appear very strange indeed that Mr. Falkenstein should have preferred to carry out his experiments in the manner stated, thereby going over ground mostly already well known, instead of on a large commercial scale with the very system which he, as electrician to the British Tanning Company, Limited (owners of the Worms and Balé drum system), has been working for some years, and which would have enabled him, and consequently also the company, to vindicate the current opinion that the said system is not based upon scientific principles, and therefore neither could be, nor has been, a commercial success, although "it has been worked on a commercial scale for some years." This is so much more to be regretted, as the company from the very first created a great prejudice in the trade by reason of the way in which it commenced operations, admitting nobody into their works, refusing to give information of any kind—only giving to the outside world, through the medium of the unsuspecting Press, in the most superlative terms, the astonishing results said to have been obtained, which, alas! never were borne out by the leather actually produced. This prejudice still remains unabated, although since then Dr. Rideal and Mr. Trotter, together with many other scientific experts of unquestionable repute and tanners of recognised standing, after working *on a large commercial scale* with "Groth's system," have proved, without a shadow of doubt, the great importance of the application of electricity to tanning. The annual value of this one of our staple industries is officially estimated at fully £50,000,000 sterling, nearly two-thirds of which is filled, sad to say, by foreign tannages, although the English tanner has the same advantages and facilities for producing the leather as those who are now inundating us with their products; but, unfortunately, the English tanner does not appreciate scientific advice, and prefers to shut up his tannery rather than to adopt modern means which would enable him to compete successfully, and thereby to reap for himself the enormous sums which are now annually lost to him and the country entirely by his apparent lack of enterprise.

It seems therefore only natural to assume that it should have been in Mr. Falkenstein's own interest to do his utmost to overcome this prejudice by investigating the Worms and Balé process; so much easier for him to do as every possible facilities were at his disposal, and for which he publicly expresses his thanks to the company, by doing which he also makes one to believe that his favourable results were obtained from experiments with the W. and B. process, which is not the case.

Mr. Falkenstein also says, having referred to the *electrical action assisted* by mechanical agitation, that besides the Worms and Balé, and Groth's systems, there are also "others," avoiding to give names or descriptions, from which it may be inferred that he considers them of less or no value. That is, however, not the case, because if there are any other systems, they would, by being worked, undoubtedly infringe the W. and B. or the Groth's system, as it is not conceivable that the tanning process could be carried out without using either a *movable* receptacle, which is claimed by Worms and Balé, or a *stationary* one—*i.e.*, the ordinary tan-pit—which is claimed by Groth, and for which he has succeeded in obtaining patents in thirty of the most important countries of the world, in spite of the most vigorous opposition raised thereto by Messrs. Worms and Balé, and which brought forward the well-known actions in the High Court of Justice in England, and the Appeal Court in Germany, resulting in Groth's favour upon all points of issue.

As to the "final result," Mr. Falkenstein continues to say "it has been established by Messrs. Rideal and Trotter . . . and Dr. Zerener, that a saving of time from 4 to 38 per cent. is obtained," which would most likely be understood to mean that Messrs. Rideal and Trotter's experiments would show 4 per cent., and Dr. Zerener's 38 per cent., whilst, in reality, it should be the very reverse; but even then the figures are wrong, as they ought to be 83 per cent., Messrs. Rideal and Trotter saying in their report, "The average values thus obtained are in the proportion of—

Ordinary tannage.	With motion.	With motion and electricity (Groth's patent).
·133	·503	2·08

or, at the rate of tannage under the influence of electricity and motion (Groth's system) is four times faster than the rate when motion alone is employed, and 16 times faster than when neither are used (ordinary tannage)."

As to the experiments using liquors prepared from different tanning materials, Mr. Falkenstein only refers to three kinds, leaving out such important materials as gambier, valonea, mimosa bark, myrabalams, etc., and if he had investigated these as well, he would have found that all of them offer a different resistance to the electric current and give a different result in accelerating the tannage by one and the same density of current. Dr. Rideal's remarks in *Industries*, however, "that such tannins which yield much bloom should be avoided in electrical work," is not in accordance with practical results obtained, as I am daily using shumac for electro-tanning without the slightest difficulty or loss of tannin, but, as I have always pointed out, "the electric current must be regulated according to the nature of the hides and the composition of the tanning liquor used in order to obtain satisfactory results."

Finally, judging from the very incomplete way in which Mr. Falkenstein has thought it right to describe the Worms and Balé process, so familiar to himself, by leaving out the most important factor therein, the turpentine, and mentioning those only of far less importance, together with other inaccurate statements referred to, and his silence upon the results he unquestionably has obtained during his years of working the W. and B. process, which would have been of some interest, even if the practical results obtained should not have turned out to be what was desired, I venture to say a doubt will be raised as to how far the other figures given by him are accurate and can be relied upon, which is to be regretted, as statements loosely made, under the shelter of customs so dear to our men of science, will thereby not only create uncertainty, but also cause delay in the progress which has for its object the obtaining of that economy in manufacture and quality of product so essential in our days of keen competition which practice and science combined alone can give.—Yours, etc.,

L. A. GROTH, M.R.I.

GAS v. ELECTRICITY.

SIR,—I have read with pleasure the paper by Mr. A'Court in your issue of the 28th inst. The author is apparently convinced that "there is nothing like leather," and in endeavouring to demonstrate this has, in my humble opinion, overstated his case.

According to Mr. A'Court, the lot of the gas manager "is not a happy one" owing to the scarcity of cannel and the lack of a substitute. However, when we remember that at present the Metropolitan and most English gas companies have reduced their consumption of cannel to an infinitesimal quantity, or altogether dispensed with it in favour of either the Clark-Maxim carburetting or other oil process, the meaning of the allusion appears somewhat ambiguous.

Again, the makers of gas lamps seem to have offended the author by claiming an efficiency of 5·4 c.p. per foot instead of 3 c.p. per foot in the three or five burner lamps in Westminster. I think it is Mr. Wigham, of Dublin, who has devised a very interesting experiment to show that the luminosity of two burners is remarkably increased if—the consumption of gas remaining the same—they be inclined to each other at a certain angle, and thus the burner which in the photometer requires one foot for each 3 c.p. may possibly in such combination accomplish all that Mr. A'Court is so sceptical of. On the other hand, thanks to my blissful ignorance, I have never had proof that a 10-ampere arc gives 1,500 c p. at 45deg. However, I have no proof to the contrary except judging by appearances, which are proverbially deceitful.

As to the number of gas lamps superseded by the arc lamps, there ought not to be much reason for having to approximate now. The figures available from the various installations give a pretty close idea on this point; indeed, if I mistake not, Colonel Haywood worked it out to two places of decimals for the City of London, where, I believe, he found that each arc lamp had allowed them to dispense with 2·75 gas lamps.

I won't attempt to deal with the point as to the penetrating power of gas and electricity in a fog, except to remark that the experience of Trinity House and mariners had decided this rather adversely to the arc lamp.

I wonder is Mr. A'Court aware of the percentage of 8 c.p. used, and the percentage of them that stand or are retained 1,200 hours? I know one large central station with a nominal capacity of 20,000 8-c.p. lamps, and not 5 per cent. of these are of that size. To secure such a candle-power the film has to be so thin that the life of the lamps is most precarious, and even when working its full power is not popular, as not giving all the light which might be expected from a substitute for the gas jet.

There was not need to have gone back to 1880 for tests as to the result of variation of pressure on the illuminating power of gas, but, unfortunately, most of those at hand prove exactly the inverse of what his brief required.

On Tuesday, March 7, 1893, Mr. W. Ivison Macadam read a paper for the Glasgow section of the Society of Chemical Industry. He did not confine himself to No. 4 batswing burner, but selected burners of the regulator type as supplied to and used by consumers, and showed that the greater the pressure the greater the light; bearing in mind that there are different burners for the different initial illuminating powers of Scottish and English gas. The admitted fact that the Board of Trade sanctions and stamps the gas-meter, and declines to certify any electric meter, would seem to indicate that, as was said of a certain potentate, "it's not half as bad as 'tis painted."—Yours, etc.,

Cork, April 29, 1893. J. P. TRAVERS, A.M.I.C.E.

ELECTRICITY AND ELECTRICAL APPLIANCES.*

BY PROF. W. E. AYRTON, F.R.S.

Submarine telegraphy was born in Great Britain, and for many years past this country has been the centre of the cable-manufacturing industry. The commercial development of land telegraphy dates from the erection of a little wire in the north-west of London; and to-day the land lines of Great Britain can hold their own in comparison with those of any other country, both as regards the rapidity of signalling and the number of messages dealt with per unit of the population. The application of electricity to the distribution of time and to railway signalling has not been neglected in this country; while Birmingham and Sheffield have acquired a world-wide reputation for their electroplate. But in the adoption of electricity for industrial purposes which require the use of large currents Great Britain has been very backward. This has arisen partly from the vast squandering of money in rash electric-light speculations that went on 12 years ago, and which put a temporary stop to electrical development, and partly from the onerous restrictions that were introduced by the passing of the ill-considered Electric Lighting Act of 1882. The fear, however, which filled the minds of our legislators that the electric lighting of our streets and houses would breed a monster as tyrannical as our water companies was gradually dispelled, and a new impetus was given to the electrical industry by the passing of the revised Electric Lighting Act of 1888. Since that date electric lighting has made steady progress in this country; indeed, during the last two years it has been advancing with those leaps and bounds which characterise British conservative radicalism.

Apart from the princely fortune that was frittered away on imaginary electric lighting projects, the capital that up to the present time has been expended in providing for the supply of electric light in Great Britain is £4,363,695, and of this £1,307,797 was expended in 1892. To this sum must be added £529,293, which has been already sanctioned by local authorities for work in course of erection, but the loans for all of which have not yet been raised, and a further expenditure of £250,000 which is projected by the local authorities of 10 other towns for the electric lighting which will probably be started within the next few months, as the tenders are already under consideration. Before the end of 1893, then, five millions sterling will have been spent in providing for the supply of electric current from public mains in this country, exclusive of the sums spent in wiring and fitting up the buildings in which the light is used.

Up to the present time, the greater part of the work has been carried out by public companies, but popular opinion is now tending towards the supply of the electric energy by the local authorities; and of the 25 new towns in which the electric supply was undertaken last year, in 17 it was carried out by the local authorities, leaving only eight to be dealt with by public companies. This change appears to have been brought about partly by the growing spirit of municipalism in English towns, partly by a still lingering dread of a public company obtaining a monopoly, and partly by the more favourable rate at which local authorities can raise capital.

ELECTRIC LIGHTING IN LONDON AT THE END OF 1892.

System of distribution.	Number of generating stations.	Number of 8-c.p. lamps connected.	Plant capacity in 8-c.p. lamps.	Distance of farthest lamp in yards.	P.D. at generating station in volts.
Low pressure.					
Two-wire with batteries	1	10,000	20,000	780	102
Three-wire	3	74,000	115,000	1,090	210
Three-wire with batteries	6	166,000	287,000	1,820	201 to 230
High pressure.					
Continuous current with batteries or motor dynamos	2	40,000	70,000	1,600	1,250
Continuous-current arc lamps for street-lighting	3	516 arcs, equiv'l'nt to about 7,500	890 arcs, equiv'l'nt to about 12,500	3,344	570 to 2,600
Alternate current with transformers in the houses	6	156,000	210,000	2,500	1,000 to 2,000
Alternate current with transformers in sub-stations............ .	1	73,000	125,000	9½ miles	2,200 to 10,000

Of the total number of electric lights run from central stations in Great Britain, about five-sixths are in London, where, at the end of 1892, there were about 526,000 8-c.p. lamps, or their equivalent, connected with the public mains, some 330,000 of which were added during the past two years. To supply current for these 526,000 lamps, there are 19 generating stations, having a total plant capacity of about 839,000 8-c.p lamps, or about 40,000 h.p.

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* The introductory monograph to the electrical section of the British catalogue at the Chicago Exhibition.

Seven different systems are employed in London for distributing the electric energy, and the approximate number of lamps supplied with current on each system is shown in the preceding table.

Hence we see that of the 526,000 8-c.p. lamps, or their equivalent, which are connected with the London public mains, 297,000 are supplied with energy by means of continuous current, and 229,000 by means of alternating current.

The following table gives briefly the approximate condition of the public electric lighting of the provinces at the end of 1892, and, as in the preceding table, the numbers given are rather under than over the truth :

ELECTRIC LIGHTING IN THE PROVINCES AT THE END OF 1892.

System of distribution.	Number of generating stations.	Number of 8-c.p. lamps connected.	Plant capacity in 8-c.p. lamps.	Distance of farthest lamp in yards.	P.D. at generating station in volts.
Low pressure.					
Two-wire	4	10,200	21,500	1,760	107
Two-wire with batteries	9	72,000	90,000	1,700	105 to 125
Three-wire	2	17,000	32,000	1,000	230
Three-wire with batteries	2	6,500	11,700	900	210 to 230
High pressure.					
Continuous current with motor dy-dynamos	2	7,000	18,000	2,550	1,000
Continuous current arc lamps for street-lighting ...	11	348 arcs equiv'l'nt to about 4,700	512 arcs equiv'l'nt to about 7,200	—	—
Alternate current with transformers	33	89,570	140,700	5,000	2,000

In addition, the following stations in the provinces are almost ready to start :

	No. of generating stations.	Plant capacity in 8-c.p. lamps.	P.D. at generating station in volts.
Two-wire with batteries.....................	1 ...	2,500 ...	105
High-pressure alternate current with transformers	4 ...	47,000 ...	2,000

So that, if we assume that the same proportion of lamps will be connected as in the other provincial examples of the same systems, we may say that the total number of 8-c.p. lamps connected, or on the point of being connected, with the provincial mains is about 240,000, of which about half are supplied with direct current, and half with alternating current. For the whole of Great Britain, including London, there are, then, about 417,000 8-c.p. lamps, or their equivalent, supplied with continuous current, and about 349,000 supplied with alternating current from public mains, making a total altogether of over three-quarters of a million 8-c.p. lamps, or their equivalent, supplied with current from central stations.

In the residential districts of London it is found that the maximum number of lamps turned on at one time is only about 30 per cent. of the total number connected with the mains; where there are shops, clubs, or theatres, this percentage is increased to 55 or 60, and in the City itself it reaches as much as 70, the average for the whole metropolis being about 40 per cent. In private houses each lamp is, on the average, turned on for only one hour in the 24, in residential flats and shops for 1½ hours, and in clubs for four hours.

The price for the amount of electric energy corresponding with 1,000 watts for one hour—one kilowatt-hour, or one Board of Trade unit, as it is called—varies, when used to produce light, from 4d. in Newcastle to 10d. in Eastbourne. In London itself it varies from 5d. to 8d.; and as this amount of energy will keep a nominal 8-c.p. lamp glowing for about 30 hours, and as the average light given out by such a lamp during its life may be taken as about six candles, one Board of Trade unit produces about 200 candle hours. Hence, at 6¼d. per unit, an illumination of eight candles for eight hours can be obtained for about eight farthings.

The actual cost of producing a kilowatt-hour, inclusive of coal, water, oil, stores, wages, and salaries in the generating station, has, in the case of the St. James's and Pall Mall Company, been reduced to 1⅘d. The sum debited to management, law charges, depreciation, and redemption fund comes also to 1⅘d. per kilowatt-hour, while repairs, rent, rates, and taxes add ⅗d., bringing the total cost per unit up to 4¼d.

The public demand for the electric current in Great Britain is almost confined to its use for lighting. The Vestry of St. Pancras have, however, set the example of offering a supply during the day for motive purposes only at 3d. a unit; but even at this price the public supply is up to the present but little used to work motors.

A new departure has this week (February 18, 1893) been made by the City of London Electric Lighting Company, who now offer electric power for heating and driving motors at 4d. per unit at any time day or night, and at the same price even for lighting from 8 p.m. to 8 a.m.

The characteristic feature of British electric light stations is the direct coupling of each dynamo to a high-speed engine, about 30,000 h.p. for electric lighting from central stations being generated by some 200 Willans central-valve single-acting engines, and about 20,000 h.p. is generated by engines of the same type for the private electric lighting of hotels, theatres, factories, etc., in this country. These engines, when of 200 b.h.p., working at about 160lb. steam pressure and condensing, are guaranteed to have 92 per cent. and 85·5 per cent. efficiency at full and half load, and to produce 1 b.h.p., with a consumption of 19lb. and 20lb. of steam in the two cases.

Great economy of space is obtained, and the absence of belts and ropes not only diminishes the trouble and expense of maintenance, but increases the joint efficiency of engine and dynamo, so that allowing for all wastes in the engine, bearings, and in the dynamo itself, 84 per cent. of the power mechanically developed by the steam is given electrically to the street mains in the case of the large direct-coupled engines working at full load.

Parsons steam turbines, first brought to general notice at the Inventions Exhibition in 1885, were for some time considered to be as uneconomical as they were interesting. They have, however, been so much improved that a 100-kilowatt turbine-dynamo, working full load with superheated steam at 103lb. pressure per square inch, can now generate one kilowatt-hour with a consumption of 28·2lb. of steam, and thus is able to compete with good low-speed condensing engines.

Such a turbine-dynamo complete weighs but four tons, and occupies hardly 42 square feet of floor space. It stands on indiarubber blocks, requires no holding-down bolts, and runs almost without vibration. Two central stations, having a total plant capacity of 14,142 8-c.p. lamps, have been fitted up with these turbines, and the price charged for a Board of Trade unit for lighting purposes is nowhere in Great Britain lower than at one of these stations—viz., that at Newcastle. Steam turbine-alternators, able to supply current for 21,428 8-c.p. lamps, are now in course of construction for the lighting of a third English town, and it is expected that with the largest of these machines, which is to run at 4,800 revolutions per minute and develop 150 kilowatts, the consumption of steam per kilowatt-hour at full load will not be more than about 22lb.

More attention has been given in this country than in any other to the design of dynamos and motors, with the result that continuous-current two-pole machines of 200 to 300 kilowatts are now constructed to run at 350 revolutions with an electrical efficiency of 97·6 per cent. and a commercial efficiency, allowing for all losses in the dynamo, of 96 per cent. at full load, this latter being only reduced to 94·8 per cent. at half load. Motors are now so well made that the average run of a locomotive on the City and South London Electric Railway before its motors require any repairs whatever is 10,000 miles, and sparking has been so completely annihilated that, although the copper gauze brushes are fixed permanently in one position, and, therefore, are not altered in lead, either for variations in speed, level, or direction of motion of the locomotive, the same set of brushes have served for a 47,000 miles run of the locomotive.

Owing to the relative cheapness of large forgings and of heavy machine work, the type of dynamo most generally employed for British central stations is that with a single horseshoe field magnet and a plain drum armature below. By ventilating the cores, and using twisted or stranded copper bars, the total rise of temperature after a six hours' run at full load has been reduced to 50deg. F.

Electromotors have not been much used in connection with manufacturing operations in Great Britain, but it is beginning to be realised that in large factories the electric distribution of power from one powerful steam-engine is more economical than the employment of many small steam-engines in different parts of the works; and in one extensive factory near London, hitherto worked by 14 separate steam-engines, arrangements are now completed for transmitting 1,200 h.p. electrically from a central steam-engine to work all kinds of machinery throughout the works.

The aggregate horse-power of all the dynamos and motors constructed in this country during the past three years appears to be about 100,000.

The fight between direct current at low pressure and alternate current at high pressure with transformers for town-lighting is now raging in Great Britain; but in spite of the fact that some users of alternate current have not succeeded in generating the Board of Trade unit for the price at which it is sold, one manufacturing firm alone in London has orders in hand for alternators to supply current for 900,000 8-c.p. lamps, and the western generating station of the City of London Electric Light Company will contain no less than 16 500-kilowatt alternators.

The self-excitation of alternators, so common abroad, is almost unknown in this country. The English practice is to join the field magnets of all the alternators in parallel, and excite them from one or more continuous-current dynamos driven by separate engines.

Central stations supplying continuous current have hitherto been frequently fitted with accumulators, with the object—first, of dispensing with the running of the dynamos at night, thus saving one shift of men; and, secondly, by sending the current through the accumulators or the street mains as the public demand varied, to keep the engines that were running at any time working at full load, and so developing their maximum efficiency. With the rapidly-increasing demand for current, however, from the London generating stations, all day and night running of the dynamos is becoming necessary, and the number of dynamos at each station is becoming large enough to enable a skilful superintendent to select a particular combination of dynamos at each particular hour, day or night, so that the output is but little short of the maximum output that combination could furnish. Hence it is probable that the period is coming to an end when accumulators will be used in London generating stations for economical reasons, apart from the reserve of power they furnish in the very rare case of a breakdown of all the machinery.

It is important, however, to notice that with the modern accumulator, average energy efficiencies of 83·5 per cent. were obtained last year with accumulators in daily use at London central stations, although the cells were often called upon to discharge at considerably above their normal discharge rates.

For private country installations, where it would be very inconvenient to run the engine during the night, accumulators are much used; also at places where the dynamo is driven by a gas-engine, accumulators supply a valuable means of steadying the light. The employment of storage cells for the propulsion of boats is rapidly increasing. There are already about 100 electric launches on the Thames, while on Lake Windermere and the Manchester Ship Canal a small fleet is in use. For these launches and for general purposes 2,200 cells were last year turned out by the English firm who construct pasted-plate accumulators, and during the same period this firm also manufactured 14,000 cells for lighting purposes.

The development of tramcar traction by accumulators has been much hindered by the cost of renewal of the worn-out plates. On the Birmingham Electric Tramway accumulators with non-pasted plates are now being tried, and, at a charge for maintenance of the cells at 1½d. per car mile, the makers of the accumulators are already reaping a profit.

While the supply of electric energy from central stations has been spreading in towns, the independent electric lighting of isolated houses has been extending in the country. This has given a great impetus to the production of efficient gas and still more recently of oil engines. The total cost, including repairs, interest, and depreciation, in a private installation with 50 16-c.p. lamps, worked with an Otto engine burning ordinary coal gas, comes to about 6d. per unit. Single Otto gas-engines are now made developing 170 i.h.p., and when worked with Dowson gas, only four-fifths of a pound of anthracite coal is burnt to produce the gas consumed in the engine per indicated horse-power per hour.

An interesting and exact experiment has been carried out of comparing the former cost of lighting the London waxwork exhibition by ordinary coal gas with the cost during the last two years of employing the gas instead to drive a gas-engine for electrically lighting the building. With gas at 2s. 9d. per 1,000 cubic feet, the cost of the gas per kilowatt-hour developed has been $1\frac{1}{10}$d., and the total cost, including, in addition, wages, water, interest and depreciation of the generating plant and of accumulators, came to 3d. per kilowatt-hour. Incandescent lamp renewals, arc light carbons, and interest on the cost of wiring and fitting up the building, amounted to not quite 1d. more per unit developed. The total cost per year of electrically lighting the building, including repairs, interest, and depreciation, came to £1,196. 2s. 6d., while gas lighting would have cost about £1,370.

Already some 100 Priestman oil-engines are employed to supply power for separate electric light installations. The consumption of oil per brake horse-power is said to be about 1lb., and the cost about one halfpenny.

Owing to the objections to poles and trolley wires in our streets electric traction has made but little headway in Great Britain, it having been almost entirely confined to the propulsion of cars along tracks not used or crossed by other vehicles. In addition to eleven more or less private track electric tramways in this country, there are two electric railways, the City and South London, opened at the end of 1890, and the Liverpool Overhead, opened at the commencement of this year, 1893. The former is 3½ miles long, and consists of two separate tubes each 10ft. 2in. inside diameter, built up of cast iron. These tubes, which contain respectively the up and the down lines, lie for the greater part of their length side by side at about 60ft. below the street-level, but where they go under the River Thames one tube is above the other, with a gradient in one place of 1 in 14. The weight of a normally-loaded train, including the electric locomotive, is 40 tons, the average speed between stations is 13½ miles an hour, the maximum speed about 23 miles an hour, and the total journey, including stoppages at four intermediate stations, is performed in 14 minutes. There is at present a four minutes' service in each direction, but when the sidings at the Stockwell end of the line are completed, the number of trains running will be increased to 12, and the interval between two trains reduced to three minutes.

The first year of this railway's life was attended with constant breakdowns, as many as nine of the electric locomotives being on occasions under repair at one time. At first it was found that the system of mounting the motor-armatures directly on the axles of the driving wheels of the locomotive was responsible for the constant destruction of the armatures. However, without any radical change having been introduced into this method of driving, the life of an armature has been much lengthened by improving the electric arrangements; and during the second half of

1892 the working of the railway became so regular, that a distance of 214,417 miles was run by the trains in that period, and nearly three and a quarter million people carried. And the cost per train mile, including all repairs and renewals, and even such extras as salaries, office expenses, superintendence, etc., was reduced to 7·1d.

The Liverpool Overhead Electric Railway resembles a tramway in that there are no separate locomotives. Two long carriages, holding 114 people, form a train, and each carriage is supplied with a motor with its armature mounted directly on the axle. The length of the line is six miles, but as the maximum speed attained is from 25 to 30 miles an hour, the distance is run in less than 30 minutes, including stoppages at 13 stations.

Submarine telegraphy is to-day carried on by means of 139,594 nautical miles of cable, and to keep these cables in repair 37 ships are exclusively employed. Nearly the whole of these cables were manufactured in England, and to this country practically all these cable ships belong. 70,215,439 paid messages were transmitted last year by the British Government's land telegraph lines, while 3,400,000 words are daily sent by the Exchange Telegraph Company to the London clubs, newspaper offices, etc., where the messages are received in ordinary Roman character by tape-printers, working automatically, at from 40 to 45 words a minute. In telephony the most recent advances are the telephone cable from London to Paris, which transmits speech with wonderful clearness, and the Government system of heavy copper-wire trunk mains which is about to be erected, with a central exchange in Leeds. From this town the telephone lines will radiate, and then between Penzance and Aberdeen, or between Dover and Oban, conversation will not only become possible, but will be carried on with far greater ease than between one part of London and another at the present time.

SOME APPLICATIONS OF ELECTRICITY TO CHEMISTRY.

Last Saturday afternoon, at the Royal Institution, Mr. James Swinburne, M.I.C.E., brought to a close his interesting course of Tyndall lectures on the above subject. In his second lecture he had just touched on a few points and difficulties connected with the manufacture of ozone, and this would be the first item in the third lecture. The formation of ozone might be illustrated in many ways, one of the most convenient being to pour a few drops of ether into a dry beaker, and allowing the ether vapour to mix with the air. If a solution of potassium iodide and starch was poured into the beaker and well shaken, a blue colour would be produced. Besides being a very powerful oxidiser it acted as a strong bleaching agent on vegetable colours, and was a useful material wherewith to attack germs. The beneficial qualities of ozone had been largely exaggerated, especially at the seaside; and the smell of the town drains had frequently been mistaken for the fumes of ozone. It had often a powerful effect on iodide of potassium, and this had been estimated by ozone-test papers—*i.e.*, papers steeped in iodide of potassium. The lecturer then passed to another branch of his subject—the production of chemical change at high temperatures, produced electrically. An experiment was made with a bottle of coal-gas in which a rod of carbon had been placed. When the electric current was applied the gas decomposed and the carbon came down in the form of smoke. The carbon on being taken out of the bottle was found to have decomposed a great deal of the gas, a rough deposit having formed over it. With a high temperature, carbon would come down in a light-grey colour. Another experiment was shown as to the amount of current that an incandescent lamp would stand. Mr. Swinburne said the Westinghouse Company had provided him with two "wasters"—*i.e.*, lamps not fit for ordinary purposes—and he proposed to try and break these with the current at his disposal. A current of 99 volts on the one lamp and 100 volts on the other were, however, insufficient to cause the lamps to break, though it succeeded in blackening the glass to a considerable extent. The electrical furnace was generally supposed to be a recent invention, but Sir Humphry Davy was one of the earliest, if not the earliest, to use it. Another early experimenter made use of the electrical furnace for the manufacture of incandescent lamps with iridium. One of the best furnaces was that invented by Messrs. E. H. and A. H. Cowles, of Cleveland, Ohio, U.S.A., who accomplished by its help the reduction of refractory oxides at high temperatures. The construction of the Cowles furnace was explained. Another furnace was shown, consisting of a copper ball with small crucible, in which a small piece of platinum was placed with an arc light on each side of it. When the current was applied the platinum was rapidly fused. An attempt was made to cause tungsten to fuse. *Though* a tremendously high temperature was obtained, so that the copper ball became quite red hot, the experiment did not perfectly succeed, though the lecturer remarked that it had fused as much as it was ever likely to do. He had devised a method by means of which the audience would be able to see what was actually going on in the furnace. This was accomplished by the aid of a mirror, which threw a reflection on to the screen. A reference was made to the experiments of Prof. Moissan, who claimed to be able to make diamonds electrically, though unfortunately only black ones. The reduction of compounds of phosphorus, silicon, and aluminium was also shown.

COMPANIES' MEETINGS.

GREAT NORTHERN TELEGRAPH COMPANY.

At the general meeting, held at Copenhagen on the 29th ult., **Mr. C. F. Tietgen,** in rendering an account of the working of the Company during the year 1892, said that an alteration had been made with regard to the way of dealing with the profits and expenses of the cable steamers in the accounts. Hitherto the profits accruing from the hire of the cable steamers had been deducted from the expenses, which might give rise to misapprehension, as, in consequence of this deduction, the accounts did not show the amount of the actual expenses. In last year's account, however, this had been put right, and no deduction had been made under the item "ordinary supervision and maintenance of the sea and land lines and repairing steamers 'H. C. Orsted' and 'Store Nordiske,'" whilst the money earned by the cable steamers had been taken into account under "sundries." This would explain the apparent increase of those two items. Matters called for great circumspection and caution, the more so as the traffic receipts were over £21,000 lower than the previous year. This was partly due to the fact that the reduced rates fixed at the International Telegraph Conference at Paris had been in force the whole of 1892, whilst in 1891 they were in operation during the last six months of the year only. It was also partly due to the continually-decreasing rate of exchange of the silver dollar, which affected the Company's remittances from the Far East in a very marked manner. These considerations rendered it advisable to place the same amount as last year to the credit of the reserve fund, whilst the Board of Directors had been enabled to recommend that the total dividend be fixed at the same amount as for the two previous years—viz., 17s. 2d. per £10 share, or about 8·60 per cent.

INDO-EUROPEAN TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held on Friday at Winchester House, Mr. J. Herbert Tritton presiding.

The **Chairman** proposed the adoption of the report, and stated that the total of the expenses account, under maintenance, in the revenue account, apparently showed an increase, but this arose from their having written down the cost of certain more or less obsolete plant and apparatus, for which they thought the year offered a favourable occasion. This was merely a continuance of former measures in the same direction, only the sum which had had to be dealt with was rather larger. There had really been a slight decrease in the actual working expenses. The revenue in the aggregate showed an increase of £700. Adding the sum brought forward of £5,983 to the gross revenue, amounting to £117,479, after deducting expenses, crediting £10,000 placed to the reserve, and after deducting the interim dividend, there remained a balance of £39,432 available, out of which they proposed to pay the dividend and bonus recommended, and to carry forward £7,557. The gross receipts for Indian business were still below those for the year 1886, when the reduction took place in the tariffs, although the number of words was greater. The fact appeared to be that in an old-established country like India there was a very different state of things to that pertaining in younger and rapidly-growing communities. There were, of course, fluctuations and periods of greater or lesser activity, but the rapid growth all round was wanting. On the other hand, the great reduction of rates made in Australia had resulted in a very large augmentation in the number of words transmitted, and he thought it was not too much to assume that if the reduced rates had been let alone the former amount of revenue would have been recovered in a very few years. The colonies, however, had found it necessary, owing to circumstances that would be in the mind of everyone, to take steps to diminish the losses that were being sustained, and an addition of 9d. a word was made to the lowered rate in order to recover not all the loss, but some of it. This small addition still left the rates very low for the enormous distance traversed. He hoped and believed that this small addition would eventually be knocked off again. The Australian colonies had to learn that the development of their immense territories and resources must be their first object, and that the adage of "Australia for the Australians," if persisted in, would be their ruin. They must encourage settlement on the land in order to develop their exports, they must ensure wisely-directed and not improvident expenditure, and they must re-establish, by rigid economy, that credit which would enable them eventually to take the lead in the commerce and production of the world. The working of the lines continued to be most satisfactory, as well in India as throughout the Indo-European system of the Indian Government and the Company. Shareholders should not, in his judgment, fail to remember that, prosperous as the Company was, there were yet contingencies which must be reckoned with in estimating the position and future of the Company.

Mr. H. Weaver seconded the motion, which was unanimously adopted.

COMPANIES' REPORTS.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Directors: Grosvenor Talbot, Southfield, Burley, Leeds, chairman; George Henry Crowther, civil engineer, Huddersfield; Robert William Eddison (John Fowler and Co. (Leeds), Limited), engineer, Leeds; Robert Hudson, engineer, Gildersome Foundry, near Leeds; Samuel Ingham (Illingworth, Ingham, and Co.), timber merchant, Leeds; Arthur Greenhow Lupton (Wm Lupton and Co.), cloth manufacturer, Leeds; John Thomas Pearson, The Hall, Melmerby, S.O., Yorkshire. Electrical engineers: Messrs. Hammond and Co., 117, Bishopsgate-street Within, London, E.C. Secretary: Wm. T. Green.

Report of the Directors to be presented to the ordinary general meeting of the Company to be held at the central electric lighting station, Whitehall-road, Leeds, on Friday, May 12, 1893, at 3 p.m.

The Directors submit herewith a statement of the income and expenditure for the past year and the balance-sheet showing the assets and liabilities of the Company made up to December 31 last. It is intended in future to make up the accounts to December 31 in each year. It will be seen that the balance at credit of the net revenue account is £11. 11s. 3d., which amount it is proposed to carry forward. The plant for the first installation of the Company's works is now practically completed, and, it is expected, will be in operation at or before the date of the coming general meeting, when the Directors hope that a large number of the shareholders will avail themselves of the opportunity of inspecting it. In response to applications from intending consumers, some extensions of mains have been carried out since the last general meeting, and the total length of culverts now laid is about 12,000 yards. In order to meet the urgent requirements of important customers, electricity has been supplied since December 14 last from temporary plant erected on part of the Company's spare ground. This supply has been maintained without interruption or irregularity, although the conditions under which it was generated were not so favourable as will be the case in running the permanent plant. The only drawback has been the impossibility of giving the supply to more than a very small proportion of the applicants. The applications for current already received are equivalent to about 10,000 lights. The demand is still growing at a very satisfactory rate, and will, it is anticipated, at an early date render it desirable to increase the capacity of the Company's plant. The retiring directors, Mr. Robert Hudson and Mr. Samuel Ingham, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re-election as auditor.

Dr. Capital Account, Dec. 31, 1892.	£	s.	d.
Lands and buildings standing thereon at time of purchase, including law charges incidental to acquisition	10,189	15	4
Buildings (erected for the purposes of the Company)	483	18	9
Machinery	756	15	7
Mains, including cost of laying the mains	5,549	15	3
Transformers	85	5	0
Meters	110	19	10
General stores (cable, mains, lamps)	801	13	10
Loose plant and tools	64	10	3
Office furniture	13	8	4
Cost of provisional order	936	19	10
Total expenditure	18,993	12	0
Balance of capital account	10,708	18	0
	£29,702	10	0

Cr.	£	s.	d.	£	s.	d.
100 founders' shares of £5				500	0	0
7,191 ordinary shares of £5 (£3. 10s. called up)	£25,168	10	0			
Less calls in arrear	1,966	0	0			
				23,202	10	0
				23,702	10	0
Mortgage				6,000	0	0
				£29,702	10	0

Dr. Revenue Account Year ending Dec. 31, 1892.	£	s.	d.
Coal, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	7	14	5
Oil, waste, water, and engine-room stores	3	15	9
Wages and gratuities	14	17	6
Hire of engine for temporary use	6	9	1
Rates and taxes	0	13	10
Fire insurance	1	3	5
Total expenditure	34	14	0
Balance carried to net revenue	70	3	2
	£104	17	2

Cr.	£	s.	d.
Sale of current	32	9	0
Rental of meters and other apparatus on consumers' premises	1	8	9
Profit on connecting and transformer house account	3	11	5
Rents receivable	67	3	0
Transfer fees	0	5	0
	£104	17	2

General Balance-sheet.

Dr. Capital and Liabilities.	£	s.	d.
Capital account	29,702	10	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1892	1,749	0	3
Sundry creditors on open accounts	553	14	11
Net revenue account: balance at credit thereof	11	11	3
	£32,016	16	5

Cr. Property and Assets.	£	s.	d.
Capital account: amount expended for works	18,993	12	0
Stores on hand at Dec. 31, 1892	33	16	4
Sundry debtors for amounts paid on account of contracts in course of completion	6,433	0	0
Preliminary expenses	1,307	17	7
Sundry debtors for current supplied to Dec 31, 1892	107	9	5
Other debtors	6	8	0
Deposit with Leeds Corporation and interest accrued due to date	1,005	1	6
Cash at bankers	4,125	4	8
Cash in hand	4	6	11
	£32,016	16	5

BUSINESS NOTES.

Bedford.—Tenders to take over the provisional order at Bedford are invited by May 13.

Church Lighting.—It is proposed to light the Abbey Church, Sherborne, and blow the organ by electricity.

Ivry.—The Compagnie Electrique de Genéve have, it is stated, purchased the Ivry works of the Edison Company.

Algeria.—The lighting at Mascara, in Algeria, is to be carried out electrically by means of a waterfall 25 miles distant.

Stockton.—The Stockton Council have declined to allow the tramways company to work the trams by means of electric wires carried overhead.

Southwark Bridge.—The City of London Electric Lighting Company, Limited, has commenced operations for the lighting of Southwark Bridge.

Bristol.—An assistant electrical engineer is wanted for the Bristol Corporation works, with knowledge of alternating-current practice, at a salary of £120.

Liege.—Tenders are required by June 10 for the establishment of a central station at Liège. Full particulars as to terms of contract and plans can be obtained from the Public Works Bureau, Town Hall, Liège.

Gloucester.—At the meeting of the Gloucester City Council, Alderman Powell, in view of the increase in the price of gas, suggested that the Streets Committee should consider the advisability of lighting the streets with electric light.

Electric Laundrying.—It is likely that electric lighting will be introduced into the Acton Wave Laundry, and electric irons will probably be adopted. Mr. E. R. Dale has been consulted on this question, and also with reference to electric motors for driving the machinery.

Canterbury.—At the Canterbury City Council meeting last week the town clerk mentioned that the agreement for the transfer of the electric lighting order had now been executed by both parties, and the deposit of £35 placed to the credit of the Corporation.

Cern Abbas.—It is proposed to turn the old watermills at Cern Abbas, Dorset, into electric charging station, not only for the supply of the town, but for charging the electric police and carriage lamps, etc. Mr. E. R. Dale, A.I.E.E., is the promoter of the project.

Bridlington.—The Prince's-parade Committee of the Bridlington Local Board at last meeting recommended that instead of hiring power to produce the electric light on the Prince's-parade, as hitherto, the Board purchase one of Crossley's gas-engines at a cost of £340 for that purpose. The committee's report was confirmed.

City and South London Railway Company.—The receipts for the week ending April 30 were £792, against £794 for the corresponding period of last year, or a decrease of £2. The total receipts for 1893 show an increase of £1,264 over those for the corresponding period of 1892.

Wigan.—At the last meeting of the Wigan Gasworks Committee it was resolved that the application for power to borrow a sum of money for the purpose of electric lighting be withdrawn from the Wigan Corporation Bill, and that an application be made to the Local Government Board for a provisional order sanctioning the borrowing of the money.

Telephone Cable.—Messrs. W. T. Henley's Telegraph Works Company, Limited, manufactured the telephone cable which was laid on the 25th ult., across the Tay, near Dundee, by their telegraph engineer, Mr. Theophilus Smith. The cable has 14 wires insulated with guttapercha, and is 1¼ miles long. It is for the National Telephone Company.

Killarney Asylum.—The Governors of the Killarney District Lunatic Asylum invite tenders for the installation and supply of electric light to the asylum. Tenders to be considered at the meeting of the Board on 18th inst. The number of existing gaslights exceed 400. All communications to be addressed to Dr. Griffin, resident medical superintendent.

Coventry Tramways.—The Coventry City Council last week finally approved an agreement with Mr. Graff Baker for the establishment of electric tramways for Coventry. The scheme has met with a good deal of opposition from a minority of the Council, but the difficulties have now been adjusted. It is expected that the electric tramways will be started by the autumn.

Telegraphic Communication to Villages.—The posts and wire are now completed between North Marston and Whitchurch, putting the village (as the local paper says) "into contact with all the world, including Chicago." On Sunday, April 16, a sermon was preached in the parish church respecting the wonders of modern discovery and invention, with special reference to the telegraph.

Sherborne.—The steam-engine which took a prize at Falmouth last year, made by one of the pupils at the electric installation, Sherborne, now drives a dynamo at the Sherborne waterworks. Electrical apparatus of various kinds is being exhibited without charge at the showroom of the Sherborne installation. Electrical engineers with specialties might possibly do business in this way in Dorsetshire.

Mortlake.—Tenders are invited for providing and fixing the necessary apparatus for lighting their works at Mortlake by electricity, for the Richmond Main Sewerage Board. Particulars may be obtained, and specification and plan inspected, on application to Mr. William Fairley, resident engineer, Main Drainage Works, Mortlake, S.W. Tenders must be delivered to Mr. J. Leslie G. Powell, clerk, 13, The Green, Richmond, by 23rd inst. Security will be required.

Cardiff.—The Corporation of Cardiff are getting on quickly with the proposed electric lighting station on the Ely Common. Messrs. W. Thomas and Co., West Bute Dock, who are the contractors for the huge works chimney, have already cleared the foundations and started building operations. Mr. W. Harpur, the borough engineer, has also prepared the plans and specifications of the engine-house, boiler-shed, and coal-stores, and tenders for building are asked for by advertisement before May 6.

Sherborne Exhibition.—At the recent Sherborne Electric and Inventions Exhibition, an old organ removed from a church some years ago was both blown and played by electricity. The exhibition itself was lighted by a 150-c.p. Sunbeam lamp. A moth trap was shown fitted with an incandescent lamp of 16 c.p. Several portable lamps for entomologists were shown, one of which was fitted with Dale's attachment for police belts. A similar lamp was shown in the Falmouth Exhibition last year.

Merveilleuse Electric Arc Lamp Syndicate, Limited.—This Company has been registered by H. T. Triemer, 3, Pinner's-court, Old Broad-street, E.C., with a capital of £15,000 in £1 shares. Object: to carry into effect an agreement, made April 20, between E. Zuccani of the one part and A. Condor of the other part, for the acquisition of certain patent rights relating to the manufacture of electric arc lamps and other electric appliances, and to develop and turn to account the same. Table A mainly applies.

Submarine Cables Trust.—The report for the financial year to April 15 states that the revenue, including £159 brought from the previous accounts, amounted to £23,261. During the year the following coupons were met: Due April 15, 1892, paid £1. 17s. 6d. balance, August 2, 1892; due October 15, 1892, paid £1. 10s. on account, October 15, 1892, £1. 10s. balance, February 7, 1893; due April 15, 1893, £1. 10s. payable April 15. The expenses of the Trust on account of the coupons amount together to £23,181, leaving £80 to be carried forward.

Gloucester.—At the quarterly meeting of the Gloucester City Council last week Alderman Powell suggested the desirability of the Council adopting the electric light in Gloucester. The gas company could not get their usual 10 per cent., and had increased the price of gas. The best course for the Council to adopt would be to have the city lighted by the electric light. in reply to Mr. Arkell, the Town Clerk explained the course of action the Council would have to take to get an installation of electric light.

W. T. Glover and Co.—The following circular has been issued by this firm: "It is with much regret that we have to announce to you the death, on the 27th ult., of our senior partner, Mr. Walter T. Glover, after a serious illness of over two years, which has necessitated his entire absence during that period. The business will be continued without interruption, and carried on, as it has been during the late Mr. Glover's absence, by the surviving partner, Mr. Henry Edmunds, M.I.E.E., with the same management both in London and Manchester."

Edinburgh.—"Lord, what fools these mortals be!" might be *the motto for some people not too* far from Edinburgh. After having decided to keep the electric lighting in their own hands an attempt, not successful, was made at the last Town Council meeting to rescind the minutes of the special meeting which approved of the town management of the lighting. Leeds has done the other way—left the lighting to go and now wants it back, so we hear. However, the Edinburgh Council resolved, after hearing all that could be said, to approve the minutes by 19 votes to 16. Auld Reekie will hae its ane licht, after a'.

Brighton.—The following were the tenders for extension of engine-house, erection of testing-rooms, coal-store, etc., and other works in connection therewith, at the electricity generating station, North-road, Brighton, for the Council (Mr. Francis J. C. May, C.E., borough engineer):

W. Hill, Newhaven	£5,595	2	1
W. Neil, Turner's-road, London, E.	3,325	0	0
W. A. Field and Co., Brighton	3,153	0	0
J. T. Chappell, Pimlico, S.W. (accepted)	2,888	0	0
J. Longley and Co., Crawley	2,839	0	0

Bradford.—At a meeting of ratepayers at Bradford, Alderman Priestman mentioned the subject of electric lighting. He believed there was far less risk now in going forward with the electric lighting scheme than there was five years ago, when the electric lighting system was started. The Bradford Corporation as an authority was the pioneer in the public supply of electricity, and he did not think that the day was far distant when the demand for the electric light would be very much greater than it ever had been. It would encourage the Corporation to extend the system if tradesmen would signify their desire to be supplied with the new illuminant.

West Ham.—The Works Committee of the West Ham Council, having further considered the question of the establishment of electric lighting in the borough, have recommended the Council to put in force the provisional order obtained in June last, and proceed to carry out the scheme for lighting the High-street, Broadway, The Grove, the Barking-road, and the Victoria Dock-road, in accordance with the advice of Prof. Robinson. The Council have, however, decided not to adopt the report, and have referred it back to the Works Committee for reconsideration, with a view to a scheme being brought up for the establishment of a central station.

Bewdley.—At the quarterly meeting of the Bewdley Town Council, held on Monday, the Electric Lighting and Water Committee reported that they had made further enquiries on the question of obtaining power from the Rivern Severn to supply the town with electric light and for pumping purposes, and had pretty fully investigated one of the schemes proposed, which they thought would probably prove successful. It was, however, an untried plan on any large scale, and the committee were not prepared to recommend the heavy outlay necessary to prove its capability. They had other projects under consideration, and would report thereon in due time.

Visits to Engineering Works.—On Saturday the students of the Glasgow and West of Scotland Technical College attending Prof. Jamieson's applied mechanics and steam classes, accompanied him on a visit to Messrs. Nelson's locomotive works and to the North British Railway Works at Cowlairs. On the previous Saturday they visited Messrs. Denny's engine works and the shipbuilding yard of Messrs. William Denny and Bros., Dumbarton. In each case, through the courtesy of the heads of the heads of the firms, the students were guided through the various works, where they saw the latest developments in engine-making, shipbuilding, locomotive construction. and repairing.

Hanley.—At the meeting of the Hanley Town Council last week the General Purposes Committee recommended that the surplus land on the north and south sides of the Hanley Park be offered for sale by auction; that 30 1,200-c.p. arc lamps, instead of 20 of 2,000 c.p. each, be provided for the purpose of street-lighting, principally in substitution for the large gas lamps; and that the electric light mains be laid for the purpose of the street-lighting by incandescent lamps at the same time as the other mains, in order to replace the remaining gas lamps. The recommendations were confirmed. On the recommendation of the Electric Lighting Sub-Committee it was decided to advertise for an electrical engineer to have charge of the construction of the works of electric installation, and the management of such works when completed, at a salary of £200 a year.

Exeter.—At a meeting of the Devon Joint Committee, Mr. Mitchelmore said he hoped the committee would provide the electric light in the new rooms in the place of gas. The local company would not lay on the current for less than 50 lights, so that they would not lay it on for the new buildings alone. The cost for laying on the current would be £78. 10s. for 75 lights of 16 c.p. and 32 c.p., and the cost of supply would be 7½d. per unit, or rather more than gas. The advantages to be gained were, however, considerable. The estimate for laying on electricity to every room in the building would be £125. 1s. Mr. Hepburn said he had had considerable experience in electric lighting, and was in favour of it. The original outlay was moderate; 7½d. per unit was a high charge, but not excessive. He was in favour of having the electric light all over the building. After some discussion it was decided to introduce the light and to refer the estimate and details to Mr. Harbottle to consult with the engineer of the company.

Aberdeen.—The Gas Committee of Aberdeen on the 28th ult., on the advice of Prof. Kennedy, accepted the tenders of the following contractors: Boilers, Messrs. Babcock and Wilcox, London, £1,494; engines, dynamos, etc., the Electrical Construction Company, Wolverhampton, £5,044; switchboards, Messrs. Siemens Bros. and Co, £990; road works, culverts, etc., Messrs. Scott and Sellar, Aberdeen, £2,671; batteries, the Electrical Power Storage Company, £760; copper strip, Messrs. Boulton and Sons, Cheadle, Lancashire, at the rate of 6½d. per pound for 30 tons, £1,820; cable, Callender and Co., £1,532; pilot wires, the British Insulator Wire Company, £190; and porcelain insulators, Messrs. Doulton and Co., £176. 15s. 8d. The total contracts amount to £17,918. 11s. 7d., which is about £2,000 under the estimated price. It was arranged that the work should be commenced in about a month from the present date. It was agreed to ask the Council for powers to advertise for an electrical engineer.

Edinburgh and Leith.—At a meeting of the Edinburgh and Leith Corporations Gas Commission held last week, Lord Provost Russell presiding, the clerk read a letter which he had received from the town clerk of Edinburgh on March 25, asking whether it would be agreeable to the Commissioners to furnish the Electric Lighting Sub-Committee of the Corporation with information as to the revenue they derived from the electric light area. Bailie Archibald said this was rather a novel application. They were there to supply gaslight for Edinburgh and Leith, and the Corporation, who proposed to start an opposition light, were simply wanting a list of the Commissioners' best customers in order to take them away. That was really the meaning of it. Just to show, however, that he had no fear of the electric light at all, he begged to move that it be remitted to the Finance Committee to give the desired information. Councillor Gibson seconded Bailie Archibald's motion. Councillor Kinloch Anderson thought they ought to congratulate Leith upon the magnanimity which Bailie Archibald had displayed. The motion was then agreed to.

Dorking.—The directors of the Dorking Gas Company have almost unanimously agreed that it is desirable for them to undertake electric lighting in conjunction with gas as soon as they can make the necessary arrangements. The price of gas favours the use of gas power, and the directors have before them a scheme for the illumination of the town by electric light, which has been drawn up by Mr. Todman, electrical engineer, who resides at Dorking. By means of this they hope to provide the town with electric light for its streets at a cost not exceeding the present price of gas. Last week the High-street was brilliantly lit up by one of Mr. Todman's "Solar" arc lamps, which was suspended outside the Red Lion Hotel. The dynamo generating the current was driven by a gas-engine, and from actual measurement of the gas used it was found that at the current price of gas the lamp cost but 2d. per hour. The trial was regarded as eminently satisfactory, the light given being remarkably steady and the effect one of great brilliancy. If the scheme is adopted, it will be significant of the changing attitude of gas companies towards the electric light.

Bombay Municipal Offices.—This installation, referred to recently, which consists of 326 incandescent lamps, varying from 8 c.p. to 50 c.p. each, is on the Thomson-Houston system, supplied by the Laing, Wharton, and Down Construction Syndicate, London, who have also supplied installations on the same system for the Kidderpore Docks and Hooghly Bridge, Calcutta, the latter installations being for arc lamps of 1,200 c.p. and 2,000 c.p. each, instead of the incandescent lamps used in Bombay as more suitable for interior work. At Bombay a high-tension current is generated in the dynamo-room at the municipal workshops and transmitted by underground cable to the municipal offices, where it is transformed to low-tension and distributed over the various circuits. The dynamo used is a Thomson-Houston alternator driven by a 25 nominal horse-power compound semi-portable engine, under a 30-h.p. boiler, by Marshall, Sons, and Co., of Gainsborough. The contractors for the whole work are Messrs. Richardson and Cruddas, of Bombay, through whom the complete plant was supplied by the Laing, Wharton, and Down Construction Syndicate, on whose behalf Mr. Percy Mossop, M.I.E.E., superintended the erection.

City Lighting.—Notification is given by the City of London Electric Lighting Company that application is being made by them to Parliament this session for a Bill to alter and amend the provisions of the City of London Electric Lighting (Brush) Order, 1890, the City of London (East District) Electric Lighting Order, 1890, and the City of London Electric Lighting (Brush) Order, 1891, with respect to the keeping of accounts and setting aside of depreciation and reserve funds, and to alter or prescribe the amounts to be debited to the annual accounts of capital employed for the purposes of these orders for depreciation and for reserve and other funds, and to provide for the investment and application of moneys so debited. The Bill will contain clauses providing that the undertakings authorised by the provisional orders mentioned shall be deemed to be one undertaking, and exempting from the operation of the Metropolitan Building Act, 1855, any building used by the company wholly for generating energy to be supplied under the provisions of the Brush Orders, 1890 and 1891, the East District Order, 1890, and the Southwark Electric Order, 1891. Printed copies of the Bill will be deposited to-day in the Private Bill Office of the House of Commons. Mr. Sidney Morse is the solicitor for the Bill, and the parliamentary agents are Messrs. Rees and Frere.

Fowler, Lancaster, and Co.—In the Chancery Division on the 26th ult., before Justice Vaughan Williams, in the matter of Fowler, Lancaster, and Co., carrying on business at Albert Works, Graham-street, Birmingham, the Electrical Company, of London, who are creditors for £159 on a dishonoured bill, petitioned for the compulsory winding up, notwithstanding the fact that a voluntary liquidation had been resolved upon. Mr. Hart, who appeared for the petitioning creditors, said the ground of the petition was insolvency. The Company was incorporated in 1890 with a paid-up capital of £17,820, and had now unsecured debts £6,500, besides £7,000 debentures. The failure was put down to lack of capital to work the business economically, to general trade depression, and to the crisis through which the electrical businesses had recently passed. The petitioning creditor and other creditors considered that their interests were not sufficiently protected by the voluntary liquidation. Mr. Farwell, who appeared for the Company, submitted that as there was no property to realise there was no object in having a compulsory liquidation, as the ordinary creditors could not be prejudiced. There was, in fact, nothing to wind up; and, moreover, there was nothing to drag to light in the public interest, as there were no charges of extravagance or fraud on the part of the directors. His Lordship, however, thought there ought to be more information as to the working of the Company and the reasons for the failure, and adjourned the case for further affidavits, or, if necessary, for the examination of witnesses.

Dundee.—At a recent meeting of the Dundee Gas Commission the following statement was submitted showing the expenditure under the Electric Lighting Acts: Expense and disbursements incurred of and incident to Electric Lighting Provisional Order, 1890, £962. 18s.; additional expense incurred of and incident to carrying out said order, £207. 17s. 7d.; machinery and plant—contracts, including extras, £20,750; buildings—contracts, including extras, £3,800; Prof. Kennedy's fee, revising plans, £113. 0s. 8d.; engineers' commission on works, £900; architect's commission on buildings, £165; Westinghouse Electric Company, Limited, royalty, £295. 10s.; salaries of clerks of works, inspector, etc., £101. 14s. 7d.; wages of men laying cable, etc., £157. 1s. 3d.; advertising and printing, expense of loans, cast-iron pipes, etc., paid, £169. 16s. 5d.; works for water supply, office furniture, apparatus and tools, advertising, etc., unpaid, £497. 7s. 4d.; total, £28,030. 5s. 10d.; contemplated additions, £2,000; together, £30,030 5s. 10d. The meeting resolved, subject to the consent of the Secretary for Scotland, to borrow a further sum of £10,000 for the purposes of the order. At a subsequent meeting a letter was read from the office of the Secretary for Scotland, stating that Sir George Trevelyan had sanctioned the borrowing of the further amount of £10,000, thus raising the total amount authorised to be borrowed under the order to £30,000. In the letter it is stated that on the further borrowing powers now conferred being exercised, an additional sum of not less than £175 should be carried annually to the sinking fund required to be established for paying off the money raised for electric lighting purposes—the augmented sinking fund, with its interest accumulations, to be applied from time to time as the Commissioners think fit, in liquidating the debt.

Belle Vue, Manchester.—The large arc light installation at the well-known Zoological Gardens, Belle Vue, Manchester, consisting of 67 lights on 20 to 40 ampere circuits, has given so much satisfaction, and been so admired for steady light, that it is being increased by means of 100-ampere arc lamps. Messrs. Jennison have again placed their order with Mr. A. W. Richardson, of Patricroft. These lamps are of the differential clockwork type made by Mr. Richardson of a similar type to his ordinary current lamp, of which there are some hundreds now in use, but of the lighthouse pattern, burning 40mm. fluted carbons, with holders of universal adjustment. The dynamo which runs two of these large lights in series, and also incandescent lamps at the same time, is also made by Mr. Richardson. It is a compound-wound machine, with inverted magnets, the cores of which, together with the pole-pieces, are of wrought iron, machined bright throughout, and are fitted on brass packings, mounted on a massive bed-plate, which carries three bearings for the armature shaft. The armature of this machine is of the ring type, with core of Swedish iron washers, thoroughly insulated, mounted on a gunmetal centre. The commutator is mica-insulated; it is of a special make, which, after long experience and very severe tests, is found to give most satisfactory results. It is fitted with double brushholders, with a spring movement, allowing a most sensitive adjustment. This machine runs continuously on full load without heating or sparking. The lamps, of which there are to be four (two duplicate ones being to illuminate the firework picture) burn, with great steadiness and without flaring, giving a very brilliant and satisfactory light. Mr. Richardson is making a speciality of heavy-current arc lamps, for any amount of current This installation is interesting, as it comprises, apart from lighthouses, one of the largest current arc-lamp circuits in existence.

Elmore Copper Tubes.—The Elmore's German Company want more money, and have invented an important improvement. The money they require is £3,000 only at present. The improvement is thus described by the chairman: "Every Elmore shareholder must by this time be aware of the important part which the mandrel plays in working the Elmore process. The mandrel has been a troublesome thing from the first. When a tube has been deposited upon a mandrel the difficulty is to get it off. It is necessary to roll it in order to enlarge it slightly, and then it often requires a force of some tons to remove it. But this is not the only weak point. There must be a special mandrel for every size of tube that may be required, and then comes a very important matter which has occupied the attention of the Board almost from the first, but which, curiously enough, does not appear to have occurred to any of the experts who have reported upon the process. It is this: That if an order is given for any considerable number of tubes, all of one diameter, and there is only one mandrel in stock of the size required to make the tubes upon, the order cannot be executed in any reasonable time. For instance, a few months ago we were applied to for

14 tubes of one size and ⅜in. thick. This order would have taken 30 weeks to execute, and, of course, we lost it. To meet this difficulty we have sought to obtain a system by which any number of mandrels could be made up quickly to any required size, and at last our manager has succeeded in making what we call a compound mandrel. A composition which is readily fusible is applied to a tube of any kind as a basis, and in this way in a few hours we can make up any number of mandrels. This is not all; but when the tube has been deposited upon such a compound mandrel we have only to turn a jet of steam upon it, the composition is melted away, and the tube is free to be removed, and of perfect shape. The system has other advantages. We can make not only plain tubes, but also objects of irregular form, and it removes the difficulty as to the quick and punctual delivery of orders."

Bradford Town Clock.—The Gas and Electricity Supply Committee of the Bradford Corporation have been making experiments in the lighting of the Town Hall clock. The clock has for some months been lighted by electricity supplied from the Corporation works, and for the electricity consumed the Town Hall Committee have paid the Electricity Committee at the rate of £750 per year. Formerly the clock was lighted by gas at a cost of £205 per year. The expensiveness of the electric lighting has led the Electricity Committee to try two new methods. One of the dials is lighted by electricity from outside—the cost for all four dials in this way would be only £95 per year, or less than half the cost of gas. The dial facing Bridge-street is lighted internally by electricity, and at a cost which would amount for all four dials to £130 a year. The remaining two dials are lighted by the previous system, costing £750 a year. The Electricity Committee have found that both the new methods make the dial as clearly read as with the more expensive means, and the only question is as to whether the new outside or the new internal system of lighting by electricity should be adopted. The internal method appears to be preferred. In the method of lighting by electricity which has cost £750 a year there have been used for each dial 18 lamps of 32 c.p., 12 lamps being affixed to a large circle, and six lamps to a smaller centre ring. Each of the lamps in the larger circle was placed behind the figure representing each of the 12 hours. In the new internal method of lighting there are behind the dial only 13 lamps of 8 c.p. each, 12 in a large circle, and one in the middle. Each of the 12 lamps, instead of being placed behind the figures, is behind the intervening space: each lamp is backed by a 10in. reflector; and all the lamps are placed about 2ft. further from the dial than those used in the more costly system. The dial which is lighted in this manner is as bright and the hands and figures as discernible as in the case of any other dial. This means of lighting applied to all four dials would cost £130 a year. But the cheapest method is that of outside lighting, such as is now used with the dial facing Nelson-street. Two rods, suspended from the tower so as to overhang this dial at a distance of about 5ft., support a ring bearing eight 10in. reflectors, each reflector having an 8-c.p. lamp in its centre. The advantage of this method is that the light has not to penetrate the glass of the dial before effecting the desired illumination. The disadvantages are that the apparatus to some small extent mars a clear vision of the clock's face, and that in a severe gale the reflectors and other apparatus might be damaged or carried away. The cost of this system applied to all four dials would be only £95 a year. Mr. S. Baynes, the borough electrical engineer, has gone carefully into the whole matter, and has carried out both the new alternative schemes. In view of all the circumstances the committee are in favour of applying the more economical method of internal lighting to all the four dials. This would mean a reduction in the amount paid by the Town Hall Committee to the Electricity Committee of from £750 a year to £130, which certainly seems a sufficient amount for lighting a clock.

Telegraphic and Telephonic Communication.—At the Bristol Chamber of Commerce on the 26th ult. it was reported that the memorial from the Associated Chambers of Commerce to the Postmaster-General had been acknowledged by letter, in which he stated that, with regard to the expression of opinion that the telegraph department of the Post Office should no longer be treated for financial purposes as a separate establishment, he had to acquaint the Chamber that whatever advantages might be derived from the adoption of such a course, the principles upon which the Government would necessarily be guided in the direction desired by the memorialists would not be affected by the change. Regard would, in any case, have to be had to the financial result of any measures of the kind advocated. It was urged in the memorial that the time has now arrived when free addresses not exceeding six words in length should be allowed in all inland telegrams, and in reply thereto it was stated that it is now the universal practice of the telegraphic administrations and the cable companies to charge for all words transmitted, whether in the address or text, and it seems to Mr. Arnold Morley that this principle is a sound one. The practice of allowing free addresses has long since been abolished. Not only is it desirable, therefore, as being contrary to the general practice, but the proposal would involve an enormous loss of revenue. From a financial statement recently issued it appears that the deficiency of telegraph revenue to meet the working expenses and the interest on the capital amounted to £389,000 in the year 1891-2, and in the face of such a deficiency the Postmaster-General cannot hold out any prospect of a further reduction of tariff. Mr. Arnold Morley further stated that he will always be glad to do all that may be possible to facilitate the extension of telegraphic communication in rural districts, and he was glad to find that under the present system of private guarantees and the operation of the Telegraph Act of 1891, which enables rural sanitary authorities to give guarantees, there has been a considerable increase in the number of country telegraph offices. A considerable number of additional extensions will be carried out during the summer and autumn of this year, and Mr. Arnold Morley is in communication with the railway companies with a view to the facility of telegraphing from railway stations being afforded wherever the arrangements of the companies admit. In response to the memorial of the Associated Chambers of Commerce, the Postmaster-General replied that he had given full and careful consideration to the representations made to him in the memorial of the Association of Chambers of Commerce of the United Kingdom with reference to the proposal of the Department to charge for the use of the telephone trunk lines by means of a fee for conversation, instead of by an annual rent. The system of charging for trunk line communication is by no means new, as seems to be supposed. It has been in operation on the trunk lines of the Department, and it is generally adopted abroad. It has been approved by Parliament under the proposals contained in the Treasury minute of May 23, 1892, and it places all users of the telephone on the same footing, and he hopes that it will not be found open to the objections urged in the memorial. He concluded by pointing out that it will still be open to any particular firm to rent a wire between two towns for its exclusive use, an arrangement which will perhaps sufficiently meet the case represented by the memorial.

Blackpool.—An important step forward in connection with the new electric lighting scheme, says, the *Blackpool Gazette*, took place on Saturday, when the foundation-stone of the Princess-street works was ceremoniously laid by the Mayor (Mr. Alderman Cardwell). Rapid progress is being made with the erection of this building, and while some of the boilers are already in position, the others are expected to be laid down within the next week, and the electrical machinery will then be speedily delivered and fixed. Mr. Councillor Pearson was able to assure the gathering afterwards that it was anticipated that all would be in readiness for the supply of electricity to those who are arranging to take it by the third week in July, but by the last week in July without fail. It remains to be seen whether this sanguine estimate of the future rate of progress will be verified. Most of the speeches at the banquet were eulogistic of the electric lighting development which Blackpool is making, and it is to be hoped that it will increase the attractiveness of the town to the extent anticipated. Some of the Mayor's guests, however, were rather anxious to know why it was that Mr. Councillor Pearson endeavoured to fix the responsibility so indisputably upon Mr. Hammond for either the success or failure of the system which is being adopted in Blackpool. If there is no reason for doubt, if everything is thoroughly straightforward, and the Council are quite satisfied that the high-tension alternating-current system is the best, why was it necessary for Mr. Councillor Pearson to address Mr. Hammond in these pretty straight terms: "If these works are not a success the whole of the discredit will fall upon your shoulders?" Surely at this early stage there is no need to think of having a scapecoat ready.—The following is the report of Mr. William Chew, electrical engineer to the Blackpool Gas Committee, upon the working of the Corporation's existing electric light installation for the past year: "Herewith I present my thirteenth annual report of the working of the electric light stations No. 1 and No. 2, which have remained under my charge. I have to report that the plant has been kept running during the year, and working at its normal capacity. The manufacturing appliances have been maintained in good condition. The principal items of renewals have consisted of switches, armatures, lamps, and lanterns, whilst the boilers have had several new tubes reinstated therein. The distributing plant is in need of repair to make it efficient for the coming year. The working expenses, I am pleased to say, have not reached the estimated cost, and there will be a moderate surplus of about £70 to the good. As we have for many years worked with a closed capital account, and no new work has this year been undertaken, we may take the working cost as that of an average year, and on this basis arrive at the cost of our supply per Board of Trade unit, which is the standard of price. I have made an analysis of our cost, on the same lines as that adopted by the new central stations that are now at work in the country. Taking the returns for 1892 of the nine leading London and provincial concerns, I find the highest cost per unit for working is 8·92d. per unit, the lowest is 3·43d., whilst the average is 4·81d., to this must be added for dividend, etc., from 1s. 3d. to 1½d. The cost of our supply was 4·46d., but is subject to a further reduction of 1d. per unit from sundry receipts, making the net cost to the Corporation of 3·46d. per unit for the electricity supplied to the lamps. Turning to the relative demand of private to public lighting, the number of private lights in use is 18 per cent. of the total, whilst the private consumption is only 5·25 per cent. of the year's output. The relative demand in June is one-third that in December, there being little private lighting in December. The output of a large town in our neighbourhood in June is just one-eighth that in January.

Newcastle Dynamos.—Messrs. J. H. Holmes and Co., electrical engineers, of Newcastle, have just completed a huge dynamo, which, being capable of lighting nearly 4,000 8-c.p. lamps, is the largest dynamo that has been made in the district. The dynamo has been tested, and gave every satisfaction. As is well known to electrical engineers, a large proportion of the dynamos in the central electric lighting stations of the United Kingdom are driven by Willans engines, which have important advantages. They are single-acting, so that the thrust of the piston-rod is always in one direction, enabling them to run for very long periods without any adjustment, and they can be closed in with perfect safety, the crankshaft always running in lubricant. With special air-cushioning, and valves symmetrically placed, the friction of the engine is so reduced that the mechanical efficiency is very high. The high speed enables the dynamo to be coupled directly to the crankshaft, dispensing with belts or ropes, and economising space. The plant in question is one of Messrs. J. H. Holmes and Co.'s "Castle" dynamos of their latest improved drum armature type, capable of lighting nearly 4,000 8-c p. lamps, the output being 115-volts pressure from 1,100 amperes of current. The armature, or revolving part of the machine, weighs over two tons, and is to be coupled directly to the crankshaft of a Willans patent compound vertical central-valve engine of I I size, capable of giving 200 i.h.p. at 350 revolutions per minute. The core of this armature is built up of about 1,700 thin Swedish charcoal iron discs, with ventilating spaces next to the shaft; these discs are carefully insulated from each other by a specially-made waterproof and greaseproof paper. The conductors are driven positively from the core by means of drivers, which rest in channels at intervals round the periphery, these conductors being built up of copper strips so split up and twisted as to prevent the formation of eddy currents, which cause heating and waste of energy. The end connections to these conductors are very compact, so as to reduce resistance and yet to secure efficient ventilation, in order that the temperature of the armature may be low after lengthened runs. This is important, and it may be stated that some of the dynamos built by J. H. Holmes and Co. have run for six months without stopping, and this on board ship. The field magnets are of forged iron, and weigh, with their copper wire windings, eight tons. These forgings rest on a brass bed, lying on the concrete foundation, and are steadied at the sides by a bracket fastened to the combination frame, which contains the engine and the outer bearing of the armature. All the latest improvements are combined on this plant, the builders' aim being to combine thorough mechanical design with electrical efficiency, the latter being over 97 per cent.; so, deducting friction and other losses, it would give a net efficiency for the dynamo of at least 94 per cent., and this maintained over long runs. One will observe in this plant its simplicity, complicated arrangements being dispensed with so as to secure the necessity of a minimum of attention in working. Dynamos of similar type, but of smaller size, have been built in considerable numbers by J. H. Holmes and Co., some of them being at work in central electric lighting stations throughout the United Kingdom; and they have in their works and under steam tests a plant of this description for the North-Eastern Railway Company, which is to be used for the illumination of the various booking and other offices at York Station. Three plants, exactly similar to above, have recently been supplied, together with boilers and complete installation, in the new premises of the Athenæum at Glasgow, this latter work being carried out to the specification of Prof. Jamieson, of Glasgow. This firm at present has some very large installations in hand, including three mills in the Lancashire district, each being fitted with about 1,000 16-c.p. incandescent lamps. They have also orders on their books for the electric lighting of 28 steamers, besides many plants for this class of work making for shipbuilders who do the wiring of the vessels themselves. Several large dynamos are on order for electric welding by the Benardos process, and this firm has recently supplied the Steel Company of Scotland with two large dynamos for this special class of work. They have also fitted up several of the largest firms in Sheffield, and have orders for an additional plant for Messrs. J. Rogerson and Co., Limited, Wolsingham Steelworks. Mr. J. F. Laycock's yacht, which is one of the largest private vessels afloat, has recently been fitted throughout with the electric light by this firm, and they are at present engaged in entirely refitting the large steam yacht "Namonna," belonging to Mr. J. Gordon Bennett, of the *New York Herald*.

Glasgow.—Last Friday the members of the Town Council met at the invitation of the Tramways Committee, and inspected several specimen cars which have been constructed with a view to use on the Corporation tramways. Two of these were cars which had been built by the North Metropolitan Tramways Company, of London. It was agreed that they were excellently built, but were too heavy. Messrs. Geo. Milnes and Co., of Birkenhead, had also built a car to the same general design as the North Metropolitan, but lighter; this, however, was considered to be too heavy, and the Falcon Engine and Car Works Company undertook to build a car, the design being still the same, but with slight modifications. This car was the lightest of the four, and the weight was not too great. A careful examination by the members of the Town Council confirmed the opinion of the committee as to the car selected. It will be interesting to have a general description of this car, in that it appeals to our readers, being lighted electrically by means of two 5-c.p. lamps actuated from lithanode batteries. As regards external appearance the design of the sample car is pleasing, and the colouring and lining effective. The body colour, which chiefly appears on the main panel and dash, is a rich crimson lake or maroon, lined with gold and edged with vermilion, forming a Greek border. The panel is in three divisions. Conspicuous in the centre division is a well-executed transfer of the city arms, and on the white under panel is printed, in sufficiently prominent gold letters, edged with vermilion, "Glasgow Corporation Tramways." The upper part of the body of the car, as also the stringer of the stair, is in white, tastefully lined. Each side has six plate-glass windows, and above each of these is a coloured pane, also of Greek design, with the city arms in the centre. Immediately above the coloured glass, and forming a full-length ventilator, is a fretwork of neat design, which further raises the side elevation. The side and end designation boards, fixed to the roof hand-rails, are 22¼in. broad. Had appearance only been considered these boards would have been limited to half this breadth, but special care has been taken to secure the protection and comfort of passengers riding outside, an increasing number of whom are ladies, and hence the breadth of the boards. It may be explained here that it is intended that all the cars shall have the same body colour, and that the top boards on the ends and sides, on which will be shown the starting point and destination of each car, shall be painted a special colour to distinguish the particular route On detached routes, such as Dennistoun and Springburn, the top boards will be white, but where the cars intermingle on one route, different colours, such as vermilion, yellow, blue, green, and brown will be used. Generally speaking, the present route colours will be followed. When, on special occasions, extra cars are wanted on particular routes the destination boards will simply be changed. This will tend to economy, as it will save the necessity of keeping a large number of reserve cars of different body colours. It is not contemplated in the meantime to allow advertisements on the cars. The entrance platform and stair form a special feature of the pattern car. The step to the platform is about 4ft. long. A stiff brass-cased rod rises from the centre to the canopy, thus dividing the entrance into two equal spaces. Provision is thus made for two passengers entering or leaving the platform simultaneously, an arrangement which will be of special advantage at central stations or busy termini. The car can be emptied or filled in one-half the time occupied in the existing car, inside and outside pessengers having separate exits. To admit of this the stair is thrown more to the one side than is usual. This will prove an advantage to the driver, allowing him not only more space for driving, but also a better opportunity of observing passengers wishing to join his car. There is no through passage on the platform, and instead of an opening gate on the off-side there is a fixed ornamental railing in keeping with the general lines of the car. Space is available under the stairs for parcels, mails, etc. The stairs and railings have been specially designed for this platform, and as regards ease and safety for passengers they seem to leave nothing to be desired. The reversible garden-seats on the top are very comfortable, and not by any means crowded. Each seat has a waterproof apron with straps for attaching it to the back. Inside the car is spacious and inviting. The slatted seats, like those on the top, are well shaped for comfort. The stopping and starting bell is worked by a rod with handles along either side of the roof. This leaves a wide, free ceiling, nearly 7ft. in height. Opening ventilators, filled with coloured glass, are placed close up to the ceiling. The car is provided with two 5-c.p. electric lights, each light having a separate battery. By a simple arrangement the coloured glass for the signal lights can be easily changed. Maroon curtains, hung with rings from a polished rod so that they can be drawn at pleasure, enhance the appearance of the interior. Lightness of draught has been secured, not only in the reduced weight of the car, but also by having the drawbars and whippletrees provided with springs. The wheel base, or distance from centre to centre of axles, is 5ft. 3in., and the malleable cast-iron super pedestals are fitted with indiarubber cushions in addition to the usual spiral springs. A projecting horse-guard is provided to prevent the car injuring the horses in the event of their falling, and as a protection for the unwary an indiarubber guard is fixed close to the rails in front of each wheel by means of a stiff tube bolted to the axle-boxes. The under frame of the car is of oak, the superstructure of ash and teak, with mahogany panels; the inside fittings and doors, walnut and teak with wainscot oak panels; the slatted or lath-and-space seats are of sequoia and pitch pine laid alternately, with mahogany fronts; and the inside of roof has ash ribs, covered with sequoia and pitch pine alternately.

Derby.—Although the work of erecting the new electric lighting station for the borough of Derby was only commenced a short time ago, rapid progress has been made and the walls of the various buildings have attained a considerable height. The building contract was let to Mr. Vernon, of Derby, and with the exception of a little delay in the supply of bricks for the engine chimney, nothing whatever has occurred to impede the progress of the contract. Some interesting details of the building and installation are given in the *Derbyshire Advertiser* of last week. The site which the Corporation have selected for such an important work to be carried on as that of the generation of electricity for town purposes is a most convenient one, inasmuch as it is close to the River Derwent, from which a constant supply of water can be obtained for the powerful engines, and for other purposes for which it may be required. A good water supply is essential to a successful installation such as will shortly be established here, and river water will meet the requirements of the case just as well as any other kind. The area of the land utilised is just a quarter of an acre, a portion of which was formerly occupied by a number of old cottages, fronting to Silk Mill-lane. The earlier stage of the work were fraught with many difficulties, which caused the borough surveyor (Mr. R. J. Harrison), and those engaged with him in superintending the work, considerable anxiety. The principal difficulty to be encountered was with respect to the foundations. The close proximity of the river naturally rendered the soil less reliable than it would otherwise have been, and before a solid foundation could be arrived at excavations had to be made at 9ft. 6in. below the level of the stream. The brickwork is all firmly bedded in good, sound concrete, and a number of stout iron girders add stability to the whole. The building consists of meter-house, engineer's office, boiler-house, and extension boiler-house. This extension has been provided as a provision for the future, but until such time as more machinery is required, the place will be used as a store for coal. The principal boiler-house is 50ft. long and 50ft. wide, and the engines put down will be three of 100 h.p. each. Other engines will also be introduced, all of the best make, and most useful type for this particular kind of work. The extra driving power will include two 200-h.p. engines, to be used as alternators, and which may be fully required at some future period. Ample provision is made for the storage of electric batteries, and a condensing engine and adequate pumping machinery also form part of the plant. These have been supplied by the Haslam Engineering Company. The large boiler-house will contain three boilers of the latest pattern, from the works of Messrs. Fletcher, of Derby, with self-feeding apparatus. The boilers are 33ft. long, and 7ft. 6in. in diameter. The other boiler-house previously referred to will also be large enough to receive three additional boilers of the same dimensions, when the growth of the installation calls for them. The central chimney, which is to carry away all the fumes and smoke from the engine fires, will, when completed, be 100ft. high, but at the time of writing it had not been carried much above 30ft. from the basement, owing to the scarcity of the special kind of bricks used in its construction. Conveniently appointed apartments are to be provided for the resident engineer and a number of employés. These apartments will be arranged above the offices, and will be fitted with the necessary appliances to ensure the comfort of the occupiers. The contracts for the whole of the engines, machinery, and other apparatus, have been let to Messrs. Siemens Bros. and Co., of London. The tender for laying the mains in the streets was only accepted a few days ago, and as soon as the builders have sufficiently advanced with the structural portion of the scheme the machinery will be put in and got ready for work. The floor of the dynamo-room is constructed upon a somewhat novel plan, and one which, it is believed, will entirely obviate any danger from the overflowing of the adjacent river. The system to which we refer is the construction of a huge basin directly underneath the apartment. The bottom and sides of this are lined with a composition which will render it impervious to water. In addition to this, a large amount of concrete has also been utilised, and it is upon this that the floor of the building will be made. The flooring will also be 2ft. higher than the highest flood ever known in that district of the town, so that there is little chance of any inconvenience being experienced from the rising of the Derwent. The total length of streets within the radius where it is proposed to lay the mains, or conducting wires, is 2¼ miles, but it is estimated that not less than two miles of this would be lit by arc lamps. The mains will be laid along the Corn Market, St. James's-street, Iron-gate, Full-street, the Market-place, the Wardwick, the Strand, Green-lane, a portion of Babington lane, and a portion of Osmaston-road. According to the estimates of Messrs. Bramwell and Harris, the engines and dynamos will cost something like £5,200, and the condensers, etc., £925. The boilers may be roughly estimated at £2,250, and the engine foundations, buildings, boiler seatings, store buildings, and builders' work generally, £2,600. The instruments, switchboards, etc., may be put down at £1,000, and the feeder and distributing mains (on the three-wire system), with high-tension mains for arc lighting and conduits for the whole, £8,800. The lamps will cost £24 each, and will bring the total cost to about £31,855. The installation will supply this high-class illuminant to 7,500 incandescent lamps of 8 c.p. each, and these will be used for the purposes of private lighting, such as the interior of public buildings, business establishments, and private houses. The lighting of the public thoroughtares will be effected by the erection of 45 lamp standards, each standard being placed in the most suitable position, so that the public may derive the fullest possible benefit from the light. No doubt in the course of time the installation which the Corporation are putting down will become much too small to meet the requirements of the people, and considerable extensions will have to be made. The Electric Lighting Committee of the Corporation have been fully alive to this, and they have shown great wisdom in following on the lines suggested by Messrs. Bramwell and Harris, and so arranging their preliminary operations as to afford easy extension in the future. When the mains are laid in accordance with the provisions of the Act of Parliament under which the work is carried out, every person residing within 50 yards of any main can demand being supplied with the light, that is, if he is willing to pay for it. With this fact in view, and also with the knowledge of the great superiority which the electric light possesses over gas, one cannot doubt but that the electric light will become extremely popular in Derby. The work is being carried out under the supervision of Mr. R. J. Harrison, the borough surveyor, and Mr. Waters, clerk of the works. Arrangements have already been made for introducing the light into the free library and reading-rooms, where the change will be a very welcome one. Care has been taken to allow of possibility of easy extension of the plant. In carrying out the work local firms have been engaged in every instance where it was possible to do so. The progress which has already been made with the work redounds to the credit of the contractors, and speaks well for the rapid completion of the scheme.

PROVISIONAL PATENTS, 1893.

April 24.

8197. **Improvements in electric distribution and apparatus connected therewith.** William Aldred, 5, Brightside-bank, Brightside, Sheffield.

April 25.

8315. **Improvements in switches for electric currents.** New and Mayne (Anthony G. New and Arthur James Mayne), *Palace-chambers*, Westminster, London.

8316. **Improvements in the electrical propulsion of boats and vessels.** New and Mayne (Anthony G. New and Arthur James Mayne), Palace-chambers, Westminster, London.

8320. **Improvements in electric cigar-lighters.** Lawrence Thayer Smith, 55, Chancery-lane, London. (Complete specification.)

8330. **Improvements in and relating to electric car brakes.** Milton E. Company, 77, Chancery-lane, London. (Complete specification.)

8331. **Improvements in electrical lock-and-block apparatus for railway points and signals.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

8373. **Improvements in electric cigar-lighters.** John Clayton Mewburn, 55, Chancery-lane, London. (Arthur Nichols Jervis and Edgar Mayhew Bacon, United States.)

April 26.

8391. **Improvements in or connected with electric bells.** Charles Turnbull, jun., 3, St. Nicholas-buildings, Newcastle-on-Tyne.

8427. **Improvements in apparatus for regulating electric currents.** Leslie Bradley Miller and Maurice Walter Woods, 2, Gray's-inn-road, London.

8436. **Improvements in controlling or regulating the supply of electricity, and apparatus therefor.** Georges Martin, 4, South-street, Finsbury, London.

April 27.

8502. **Improvements in electrical railways and tramways.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alfred Diatto, Italy.) (Complete specification.)

April 28.

8567. **Improvements in portable electric lamps.** Octavius March, 14, New-inn, Strand, London.

8571. **Improvements in or connected with cells for electric batteries.** Henry Coward Warth Emery, 33, Chancery-lane, London.

8600. **Improvements in continuous-current dynamo-electric and electro-dynamic machines.** Alphonse Isidore Gravier, 191, Fleet-street, London.

April 29.

8618. **Improvements in multiple change-over mechanism for electric arc lamps.** William James Davy, 41, Wandsworth Bridge-road, Fulham, London.

8649. **Improvements in telegraph insulators.** Joseph Morris, 6, Lord-street, Liverpool.

8654. **Improvements in electric arc lamps.** William James Davy, 41, Wandsworth Bridge-road, Fulham, London.

8675. **Improvements in or relating to galvanic batteries.** Richard James Crowley and John Russell Grant, 24, Bouverie-street, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1889.

2331. **Decomposing substances by electricity.** Dowland and Mills. (Second edition.)

1892.

6707. **Registering supply of electricity.** Kapp.

7029. **Electric cables.** Hardingham. (Felten and Guilleaume).

8743. **Electric wire couplings.** Shiels.

10523. **Arc lamp standards, etc.** Spence.

10706. **Electric telegraphic communication.** Smith and Granville.

10818. **Electrical conduit.** Bollé. (Jifferson.)

16142. **Telegraphic receiving instruments.** Hoffgaard. (Fyrd.)

1893.

1620. **Electric incandescent lamps.** Hall and De Marr.

2600. **Electric incandescent lamps.** Haddan. (Dedreux.)

4869. **Obtaining chlorates of the alkalies by electrolysis.** Gibbs and Franchot.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5½
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6¼
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Obituary.—Sir James Anderson died last Sunday morning.

Brighton Seashore Railway.—The Brighton and Rottingdean Seashore Electric Railway Bill has been read a third time in the House of Commons.

Electric Testing-Recorder.—At the meeting of the Institution of Engineers and Shipbuilders in Scotland, at Glasgow last week, a paper was read by Mr. John Barr on "Testing Machinery and Electric Recording Apparatus."

Primary Batteries.—At the students' meeting of the Institution of Electrical Engineers on May 19th, to be held in the library of the Institution, a paper will be read by Mr. William R. Cooper, M.A., on "Primary Batteries in Theory and Practice."

Storage Cars.—An exhaustive practical test of the Waddell-Entz storage battery traction system is shortly to be made in New York. Ten cars will run on the Second-avenue. The financial backing is ample, and the test will be one of more than usual interest.

Parliament.—The Board of Trade have arranged for the appointment of a joint committee of the Houses of Parliament to consider the electric traction and telephone question. It is to be sincerely hoped the matter affecting such wide interests will be once and for all satisfactorily settled.

Stanley-Kelly Two-Phase Motors.—The American papers are giving particulars of the Stanley-Kelly two-phase alternating-current motor, made by the Stanley Electric Company, of Pittsfield, Mass., who are now actually supplying practical alternate-current motors of 10 h.p. to 80 h.p., some of which have been running for months without hitch.

Forced Draught.—Those who are interested in hearing what inventors have to say on the question of forced draught for boilers should get a leaflet by MM. E. and P. Sée, of Lille, who are introducing the Neuerberg system. The air is led in by a number of small jets of air at low pressure by an air-fan. Many boilers have been fitted in Germany and some in London with satisfactory results.

Cloud Advertising.—An exhibition of advertising electrically on the clouds is to be given from the top of the *North-Eastern Daily Gazette* buildings, Middlesbrough, on Thursday and Friday evenings. Fortunately for most of us, clouds cannot be reckoned on, and there are none just now, or the sky might become like unto the interior of a railway station. As a means of signalling election results, however, there may be "a future" (as the papers say) in the scheme.

Lighting by Primary Batteries.—Amateurs (and others) constantly enquire what success has been attained in lighting by means of primary batteries. "Sigma," the estimable correspondent of the *English Mechanic* and an old friend of the electrical world, says, "What success? One word answers — none. Several successes have been announced, but the only success attained has been the promotion of companies and the liquidation of the same. There is no prospect of any success."

Leeds. — The Yorkshire House-to-House Electricity Company inaugurated the opening of their new central station at Whitehall-road, Leeds, on Wednesday, by a ceremonial switching on of the current by the Mayor of the city of Leeds, and a dinner. The ceremonial operations and the speechifying were excellent of their kind. No hitch occurred, and we must confess to having never before heard a better set of after-dinner speeches. The work at the central station will be described in due course.

Liverpool Overhead Railway.—A most interesting illustrated account has been issued by the Electric Construction Company of the Liverpool Overhead Electric Railway, containing an extract from Lord Salisbury's speech at the opening, a short description of the railway, and nine pages of photographic reproduction and plans of this great achievement of electrical engineering. It makes a noteworthy *souvenir* of the railway, which electrical engineers and engineers generally will be pleased to possess.

Theodore Puskas.—The inventor of the telephone newspaper, Herr Theodore Puskas, has just died in Budapest. He was regarded as one of the leading electricians of Hungary, where he started the telephone exchange. Besides electrical problems, he was greatly interested in aerial navigation. Puskas was most anxious to arrange a telephone system to be heard by a million speakers at once, and his last invention was in long-distance telephony, the secret of which probably died with him.

Electricity on Shipboard.—An interesting technical lecture on "Electricity on Shipboard and its Management" was delivered in the Marine Engineers' Institute, Sunderland, on Monday last week, by Mr. W. H. Flood. Mr. Alfred Harrison occupied the chair, and there was a large attendance of members. In the course of his lecture Mr. Flood explained the construction of the dynamo machine, with the assistance of blackboard diagrams, together with the process of installing the electric light on board ship and its management. The lecture was much appreciated, and a hearty vote of thanks was unanimously accorded to the lecturer.

Death of a Pioneer.—The death is announced at Gibraltar of M. Ch. Victor de Souty, who was among the pioneers of submarine telegraphy, He was in 1858 in the service of the Atlantic Telegraph Company, and became manager of the Newfoundland station after having taken part in the laying of the first Atlantic cable. He was also engaged in the laying of the 1865 cable. He afterwards served the English Government in the New Zealand telegraph service, and at his death occupied an important position in the Eastern Telegraph Company at Gibraltar. M. de Souty contributed to the development of duplex working of cables, and his name is associated with the method of comparing electrostatic capacities.

Batavia Exhibition.—The last inward mail has brought to the agents (Messrs. Jno. Birch and Co., 40, Chapel-street, Liverpool) an intimation from the committee of the Foreign Section of the Batavia Exhibition that they will be glad to receive photographs of all descriptions of machinery and manufactures of a kind likely to be suitable and interesting in the colony, and they will also be pleased to have catalogues from manufacturers for distribution. The agents will be only too glad to give any further information to firms or persons desirous of taking advantage of the above, but communications on the subject should be addressed to them as quickly as possible, seeing that the exhibition opens on August 1, and that the last exhibits must leave here not later than a month from now. Messrs. Birch have undertaken the electric lighting of the main portion of the exhibition, and as they are sending out attendants they will be willing to give assistance in the distribution of catalogues to any who wish to take advantage of the above invitation.

Telephone Companies.—So the New Telephone Company has now gone to the wall. Practically owned by the National, who have moved to its offices, nothing is left but a name. Mr. Somerville has gone to Manchester, and all the other officers have been paid off. Nothing seems to remain but dissolution. But no one knows. We hear that the Post Office have sent an ultimatum to the National with reference to the use of trunk lines, only consenting to give powers on the condition that the New Company was to be allowed to go on—that is, that all competition was not to be squashed. The National will object and try to use their own lines. What remains to be done, if we may prophesy and suggest, is that the municipalities should take up the telephone question as they have the electric lighting. The Post Office would grant licenses to the various towns for their own exchanges, reserving simply the charge on the trunk lines. This development would tend to keep out absolute monopoly, and preserve the utility of the telephone to the municipal and governmental factors of the nation at large.

Cut-Outs for Electric Railways.—Mr. W. E. Harrington (in the *Electrical World*) discusses the comparative value of magnetic and fuse cut-outs for electric railways, in favour of the magnetic species. Fuses on motor circuits of street cars, he says, will not act when grounds and short circuits occur, because the fuse metal will pass currents for a short time far in excess of their normal. It is this defect which renders fuse cut-outs valueless for motor circuits, where the excess is often momentary. The objection urged against magnetic cut-outs for electric railway work is that they are too sensitive, that they open the circuits on the overload the motors are expected to carry, and that they are too expensive and not adapted for rough usage. In reply, sensitiveness is exactly what is required: the current of overload is a question of adjustment—30 per cent. in excess is about right. The magnetic cut outs need not be much more expensive than fuse-boxes; and as for practicality, this is a question of design. The writer, among others, he states, has invented a street-railway magnetic cut-out which meets the requirements of practice.

Accumulators in Italy.—At Milan we learn that the replacement of primary batteries by accumulators has resulted in a reduction of expense for current by as much as 90 per cent. There are 322 accumulators, and the "negative" current is used. A second example of use of accumulators in Italy is that of the Societa Genovese, which has a hydraulic power of 100 h.p. during 24 hours at disposal. This power was only used in the evening, and then drove two dynamos of 275 amperes at 115 volts. The current, distributed on the three-wire system, supplied 1,100 16-c.p. lamps, which gives 176 c.p. per horse-power. Accumulators have been put down, and the two dynamos, with a third spare one, now charge the cells during the day. Each battery has a capacity of 600 ampere-hours, with a discharge of 179 amperes, and are capable of supplying 716 16-c.p. lamps for 3½ hours. The dynamos supply 1,100 lamps, the battery charged during the night by the spare dynamo gives 716, and the two others charged during the day bring this latter number to 2,148—a total of 3,964 16-c.p. lamps from 100 h.p., or 40 lamps and 640 c.p. per horse-power.

Peyrusson Accumulator.—M. Edouard Peyrusson presented to the Société Française de Physique recently an accumulator of large surface formed of lead plates of only half a millimetre thickness, but rendered strong by "armatures" of antimony-lead alloy. The positive electrode formed of a central rod round which radiate the positive plates, is assured of a long life, as wearing takes place from the circumference to the centre, to which it only penetrates slowly, so that the conducting part is the last attacked, exactly contrary to the usual case. The electrode can thus be used at its best period, for "accumulators usually fall to pieces when at their best." The negative electrode is *formed of similar bands of* lead, folded so that action takes place on both surfaces. The cell has only one positive electrode in the form of a cylinder, and the negative is a hollow cylinder into which the positive penetrates, just kept from contact by china covers. The supervision is easy, the internal resistance is less than that of the usual forms, and the capacity is greater for the same weight by reason of the thinness of the plates employed—this capacity, moreover, increasing (as in all Planté cells) as the cell is used.

Boudreaux Dynamo Brushes.—The new dynamo brushes introduced by M. Boudreaux are composed of exceedingly fine sheets of metal foil, bent and consolidated under pressure to the size of the brush. The metal employed is an alloy of copper of the kind called "anti-friction." The sheets run as many as 1,000 to the inch. From this extreme sub-division results a softness of rubbing which reduces the wearing of the commutator to a minimum. The rubbing surface being continuous, and not composed of minute scratching surfaces, as in gauze and wire brushes, polishes the commutator to a brilliant surface. For the same size the weight of the laminated brushes is twice that of the gauze brushes, and their conducting power is therefore greater. The reduction in resistance is very noticeable for low-pressure dynamos. Trials have been made with all kinds of machines at pressures from 2 to 1,500 volts with very satisfactory results, and the saving in wear of brush and commutator experienced will doubtless draw the attention of electrical engineers to the detail in question. It is not necessary to turn up the commutator again, but simply to polish it well with fine emery-cloth.

Tesla.—A long and interesting interview with Mr. Nikola Tesla, with an account of his work and history, is given in the New York *Herald* for April 23, and is reproduced in the *Electrical World* of the 29th. His great idea is to disturb by powerful machinery the electricity of the earth, setting it in vibration. Proper appliances would take up the energy transmitted by these vibrations, and he is hopeful that the time is not far distant for giving this method a practical trial. One wire will only be necessary. He even believes the time may come when Niagara's energy will be transmissible without wires. He thinks we might telegraph direct right through the earth; universal time could be thus established, and short important messages could be transmitted simultaneously over the world. A great amount of energy can be sent into the human body by means of high currents, because the energy is dissipated laterally. Mr. Tesla notices also the importance of being prepared for a shock, when the effect on the nerves is not nearly so great. He has received currents of a pressure as high as 300,000 volts with high alternations without harm, streams of light coming from his hand. He thinks the problem of utilising waterfalls to be as important or even more important than that of attempting to obtain electricity direct from coal, for then we have energy without consuming material, and the forests and earth remain untouched.

Decimal System.—Messrs. Willans and Robinson, of Thames Ditton, Surrey, have now adopted the metric measures in their works. They have adopted this course owing to the practical convenience of the metric system, and to their conviction that they thus obtain commercial advantages in securing orders in those countries where the metric system is in force, and in order that parts of engines made by them may be interchangeable with those made by their licensees abroad. We are authorised to state that their existing standard sizes of engines, chiefly used for non-condensing purposes, will remain unaltered, in order, among other reasons, to avoid causing inconvenience to present users of their engines, the gauges, templets, etc., only, for the sake of uniformity in the works, being re-stamped to the nearest hundredth of a millimetre. A new series of engines, however, specially designed for condensing work, which is now in hand, and all new works will be constructed to even measurements on the metric system. Mr. Charles Louis Hett, of the Turbine Foundry, Brigg, also contemplates adopting this system of measurement in his works. The New Decimal Association, whose address is Botolph House, Eastcheap, are gradually obtaining adherents to their proposals for the introduction of decimal measures, and doubtless other manufacturers, especially of the more scientific apparatus, will be glad to follow when it is shown that benefit is likely to result.

Goebel's Lamp.—This time Mr. Heinrich Goebel, "original inventor of the modern incandescent lamp," comes off triumphant. As we noted last week, the Columbian Incandescent Lamp Company brought forward Goebel's lamps and affidavits against the Edison injunction, and Judge Hallett, on April 21, refused to grant an injunction. This opens the lamp trade once more in America, though of course the fight is not settled. Goebel claimed to have made a lamp essential in all elements to Edison's as early as 1854. The principal objection urged was that this was an impossible date. The judgment states : "It is said that Goebel is involved in contradictions and misstatement of facts due to the lapsing memory of old age or to untruthfulness. Be it so ; he does not appear to be an adventurer or an impostor. It is not reasonable to believe that he made the story related in his affidavit and did not make the lamp he has described. Whatever may be said as to Goebel's veracity, he is supported at many points by witnesses of good repute who speak with precision and apparently with deliberation. As already suggested, it is not necessary or profitable to go over the testimony at length with a view to determine the relative value and weight of every part. It is enough to say that there is a fair preponderance of testimony in support of the Goebel claim." The injunction was therefore refused, on the Columbia Company giving a bond of 20,000dol. conditioned for the payment of such claim (if any) decreed in favour of the complainants at a final hearing.

Rule for Direction of Current.—M. Heinrich Kratzert, of Vienna, professor and engineer, gives a rule for finding the direction of a current in an armature which he has found easy and useful : "When the armature turns to the left, the lines of force and the direction of the current are in the same direction on the part of the armature looked at from the end ; they are in opposite directions if the armature turns to the right." Some diagrams illustrating this rule are given by M. Kratzert. Suppose a ring armature is seen rotating with the commutator in front and the pulley behind between poles, the N above and the S below. For an observer placed looking at the commutator the movement of the top of armature is from right to left ; for a person standing opposite the pulley, the rotation is from left to right. To determine the direction of current on the front part of the armature, the armature must be looked at from the commutator end. The machine turning to the left, the rule is lines of force and current are in the same direction. At the opposite end the direction must be looked at by an observer looking at the pulley ; the armature turns to the right and the directions are opposed. The current in the forward or commutator end is, therefore, as the lines of force, downwards ; passes then through the coils from front to back, and traverses the further or pulley end from bottom to top ; coming back from back to front. The rule is applicable to inverted or multipolar types. It has been communicated by M. Kratzert to the Electro-technical Society of Vienna as an easily remembered practical engineering rule.

Capacity and Self-Induction.—The introduction of high-tension alternating circuits has given a far greater importance to the factors of capacity and self-induction than the early electrical engineers imagined possible. Mr. C. P. Steinmetz, in the *Electrical World*, discusses these problems from the practical standpoint. He mentions the "Ferranti effect," the explanation of which he gives graphically. He discusses a case similar to that of Frankfort—that is, the transmission of 200 kilowatts at 25,000 volts and 50 periods over a distance of 50 miles—an interesting present-day problem. With a charging current of 3,000 amperes, 210 amperes more come out than goes in. He gives the reason : the current ahead of the E.M.F. in the first transformer and the first part of the line, producing the rise of potential in the transformer, the decrease of current in the line. In the dynamo the low-tension feeders, the last part of the line and the second transformer, the current lags behind the E.M.F.; hence self-induction causes the potential to drop, but the capacity causes the current to rise. The dynamo has to produce 66·25 volts to get 40 volts to the receiving end. Very different are the conditions at light load of 2,000 amperes. At 31 volts the dynamo sends 2,900 amperes into the circuit, and 2,000 amperes at 40 volts come out at the other end. The potential rises from 31 volts at the dynamo to 44 at the secondary of the first transformer, and then slowly decreases ; the current decreases in the first part of the line, and remains almost stationary in the last. The current is in advance of the E.M.F. everywhere except at the end of that line and in the second transformer, and has no lag in the dynamo and receiving circuit. At open circuit, 10 volts is sufficient to maintain 40 volts at the end of the circuits—that is, the combined action of capacity and self-induction have raised the voltage four times. Mr. Steinmetz discusses other circumstances, such as moisture on the line and increase of line capacity. All this represents extreme conditions—small power transmitted at very high pressure over long distances at low generating and high line pressures. Usually lower line potentials and higher generator potentials would be rightly used.

A New Insulating Material.—A new insulating material bearing the name of "Stabilit" has been tested by the General Electricity Company, of Berlin, and the results having proved satisfactory it is now being brought into commerce. This material, which has for some time past been used in the insulation of armatures and magnet and transformer coils, is made in plates, bars, and tubes, or in any desired form, in red or grey-black colour. It can be turned, bored, and polished more easily than indiarubber or vulcanised fibre. It is free from acidiferous or corroding substances, and does therefore not attack metal, and is consequently considered better than any material for the insulation of commutators, magnet coils, switches, etc. After four weeks' exposure to a damp atmosphere, stabilit showed no alteration in weight or in its insulation resistance, whereas under the same conditions vulcanised fibre increased in weight by 20 per cent. in 24 hours, and its insulation correspondingly decreased. After being boiled for 12 hours no increase in weight was noticed, whilst hard rubber and vulcanised fibre soon became soft. When placed in a paraffin bath vulcanised fibre became brittle at 200deg. C., and at 250deg. C. it began to carbonise ; rubber became soft very early, and only stabilit withstood that temperature. Stabilit, the specific weight of which is 1·6, is not attacked by muriatic acid or dilute sulphuric acid, and is therefore suitable for accumulator cells and battery jars, as experiments have shown.

The following figures show the specific resistance of the new material as compared with vulcanised fibre. The first line shows the insulation resistance of both after being exposed to a temperature of 30deg. C. for eight days; the second after they had both been exposed for 24 hours to the influence of ordinary atmospheric temperature; and the third, after the materials had been exposed to a moist atmosphere for four weeks: specific resistance in megohms (15deg. C.) per cubic centimetre.

	Stabilit.	Vulcanised fibre.
In a dry condition	10,000	8,000
Exposed to the temperature of a room for 24 hours	9,000	45
After four weeks' exposure to moist atmosphere	8,500	6

The above figures were obtained by the use of a Thomson astatic galvanometer. The test pieces were plates of 100 square centimetres, and from 0·5mm. to 5mm. thick. In the course of tests made to determine the usefulness of stabilit for high-tension insulation, plates of 0·7mm. in thickness were not pierced or broken at 5,000 volts.

High - Frequency Apparatus. — At the Royal Society's soirée on Wednesday, Sir David Salomons, Bart., and Mr. L. Pyke exhibited a machine for converting a continuous current of ordinary supply-main potential into an alternating current of 200 volts and about four amperes, having an alternation periodicity of one million per minute. The machine was built to the order of Sir David Salomons, and was constructed in accordance with his and Mr. Pyke's joint patent. The manner of driving adopted is by means of two two-kilowatt electromotors upon a true and rigid base, their armatures arranged to revolve in opposite directions, and the field and armature of the alternator being carried upon the inner ends of the armature shafts in the manner familiar to those who have seen recent machines made under this patent. There is a very important alteration in the method of constructing the field and armature of the alternator as compared with their other models, for iron has been as far as possible eliminated from the armature by causing it to occupy a ring form inside and on the surface only, of which the secondary or armature winding is arranged in a Kelvin zigzag of 276 parallels. The iron core is magnetically continuous in the direction of rotation, but being of insulated iron wire it is discontinuous in the desired direction, and the eddy currents set up are inconsiderable; and as there is no metal in proximity to it, save the armature winding (which is of insulated strand specially manufactured for the purpose), there is no loophole for loss, an additional precaution being furnished by the fine lamination of the field magnets. Both the mahogany carrier for the armature winding and core (which, it may be incidentally stated, weigh under 2lb.) and the field, consisting of 138 double-pole magnets, are carried on well-shaped gunmetal discs close up to the bearing-point of the shaft. There was also exhibited continuous-to-alternating-current transformer, the design and purpose of which is to change a continuous current of 100 volts and eight amperes into an alternating current having an E.M F. of 100 volts and an alternation rapidity of one million per minute. This is effected by means of a motor-driven alternator, the requisite alternation frequency being obtained without an excessive speed by rotating the field and armature of the motor in opposite directions, the brushes of the commutator proper being carried by the field. They also showed a small inductor dynamo and motor capable of giving at the low speed of 740 revolutions per minute 1 h.p. of electrical energy. The field is excited by one or two cells of a storage or other battery, and the efficiency of the machine exceeds 90 per cent. This great efficiency is ascribed to the close construction of the magnetic field, and the fact that the whole of the metal subject to even the smallest variation of magnetic density is laminated. The small high-tension closed-magnetic-circuit transformer, also exhibited, has been already described by us. It is for use in connection with supply companies' alternating-current circuits to raise a normal E.M.F. of 100 volts to 5,000 volts. The quantity of current which it furnishes at this potential is sufficient to very brilliantly illuminate vacuum tubes.

Testimonial to Prof. Garnett.—On Saturday, at the Durham College of Science, Newcastle, an interesting ceremony was held to present to Prof. Garnett, the principal, a handsome testimonial, in the shape of two instruments for use in the laboratory, from the artisans and others who had attended his course of lectures on "Pioneers of Electricity." These lectures were free, and were attended by over 700 electrical engineers and students. The instruments were, first, Lord Kelvin's multicellular voltmeter, reading from 60 to 200 volts; and second, Lord Kelvin's electrostatic voltmeter, reading from 200 to 4,000 volts—both instruments having been made by Messrs. White, of Glasgow, and reading over the whole range of pressure usually employed in electric lighting. At the presentation Alderman W. H. Stevenson presided, and there was a large attendance. The proceedings were opened by Prof. Ryan, of Bristol, who gave an address urging the necessity for further technical education, not only by Government, but by the municipalities. Prof. Ryan quoted from the address of Dr. Anderson, president of the Institute of Mechanical Engineers, who said that the superiority of foreign engineers was due to the fact that they were theoretically trained before they were put to practical work. No man had devoted himself more unremittingly and unreservedly to the service of the working-man than Principal Garnett had done, nor had anyone done it so unostentatiously, and with so little leaven of unselfishness. The presentation which they were about to make showed that the working-men of Newcastle appreciated what had been done for them. The chairman said he believed that the principal's action was inspired by an article which appeared in the *Newcastle Chronicle* early this year, in which it was said that it would be a very desirable thing if Principal Garnett, or some other learned luminary, would commence a series of public deliverances on the practical side of scientific subjects. He believed that, immediately on the matter being represented to Prof. Garnett, and an intimation being given to him that it would be very acceptable to the intelligent artisan classes that he should organise and carry on such a series of lectures, he at once, with that readiness and generosity of soul which was one of his characteristics, responded to it. The outcome was that during 10 consecutive weeks Principal Garnett had delivered 10 consecutive lectures—or rather 20, for each lecture was delivered twice each Saturday. The classes had consisted of between 600 and 700 students, half of whom Prof. Garnett had met each Saturday from 5 p.m. to 6.30 p.m., and the other half from 7 p.m. to 8.30 p.m. In point of fact, he had done two men's work without grudging. Mr. Thomas Chandler, on behalf of the subscribers, presented the instruments to Principal Garnett. He said he felt that they had a great privilege in attending the lectures on the "Pioneers of Electricity." The matter which had been put before them had been culled from a great many sources. By biographical extracts, by selections from their works, by lantern illustrations, by anecdotes, and in some cases by personal recollections of these eminent men, the individuality of each one had been most vividly placed before them. In fact, in the epitome of the labours and discoveries of each pioneer, Principal Garnett had taken them by gradual stages through the whole range of electrical science and its pursuit, from the simple excitation of amber up to the intricate interactions of electrical currents, magnets, the magnetisation of light, and such-like phenomena; and on the theoretical side, equally, from the original conception of a spirit residing in the amber up to the most advanced scientific hypothesis of to-day as propounded by Prof. Clerk Maxwell. He asked Principal Garnett, in the name of the students attending both the classes, to accept the instruments as a present, through him, to the college, hoping that they might in no small degree be a help not only in spreading the facts of electrical science as already discovered, but also in increasing their knowledge in the domain of original research. Principal Garnett, who was received with enthusiastic cheering, said it afforded him pleasure which he could not express to accept, both on the part of the college and on his own part, that very handsome present. He expressed his most sincere thanks to the chairman not only for the words he had spoken, but for the substantial sympathy which he had shown. He alluded to the extensions of the college which were to cost £20,000. He was grateful for the gift of instruments which were to go to the College of Sciences from the members of the classes attending the course of lectures delivered last winter. He was extremely glad that the presentation came at that moment. An attempt had been made to raise a sum of something like £1,000 for the further equipment of the physical laboratory with valuable instruments, and a promise of £300 had been received, conditional upon £750 being raised within three months, leaving them £450 to collect. Those presents came just at the right time. They were instruments which were in the list for which they were asking the money, and left the amount yet to be subscribed only some £400. Votes of thanks to Prof. Ryan and to the chairman terminated the proceedings.

Giraud's Thermo-Electric Stove.—A correspondent to the *Times* writes: "Ever since the practical introduction of electric lighting in our midst in 1878, dynamic electricity has proved the great centre of attraction to electricians, and around it have clustered some of the most brilliant achievements of electrical science. The potentialities of dynamic electricity appear to have led investigators to ignore the more modest claims of thermo-electricity as a source of light, and it has been to all intents and purposes neglected. Of late years, however, it would seem to have attracted some attention as affording a possible means of furnishing both light and heat. Hence some of our leading electricians have investigated the principle with the view of developing it into practical usefulness. Several attempts have been made to utilise it, but none of them have hitherto succeeded commercially. Its utilisation has, however, now been accomplished in an ingenious manner by Dr. Paul Giraud, a French savant, who has perfected a thermo-electric stove by which the purposes of both heating and lighting are subserved. Before describing this invention it may be as well to point out that the principles upon which it is based were discovered by Prof. Seebeck in 1821. He found that he could produce an electric current by heating one of the junctions of a metallic circuit composed of two dissimilar metals soldered together, and to the current thus produced he gave the distinctive name of thermo-electric. The principle was further developed by Oersted and Fourier, who constructed the first thermo-electric battery, which was again improved upon by Nobili, who so disposed the elements as to combine a large number of them in a small space. Thermo elements are well adapted to produce constant currents, and on this account Ohm used them in the experimental establishment of his law. The utilisation of the principle has since been studied by Clamont, Edison, Gulcher, and others, but I am not aware that their labours have resulted in the introduction of a thermo-electric system into practice. Dr. Giraud's thermo-electric stove is, as its name indicates, for the production of heat and electricity, the current being used for lighting or for any other purpose. A portion of the heat is utilised in producing the current whilst the remainder serves for heating purposes. This stove consists of an inner chamber which constitutes the stove proper and in which the fuel is burned upon the slow-combustion principle. This chamber is cylindrical, and around it, at a given distance from it, are arranged the elements in a series of rings forming the battery and connected up from the bottom to the top of the stove. Outside all is the stove casing, which is of iron, the whole resembling an ordinary closed heating-stove. The elements are formed of a homogeneous and constant alloy, having antimony for its base. They are of a special form, and are connected together by plates of pure copper. They are arranged side by side around the stove and from top to bottom, their sockets being placed against a metal tube surrounding the combustion-chamber of the stove. This tube, by conductivity, transmits the heat of the stove to the elements through a layer of asbestos board impregnated with silicate of soda, which is not acted upon by heat, and which serves to insulate the elements electrically. The elements are also further insulated by means of a paste composed of asbestos and silicate of soda. At their outer extremities the elements are cooled by being exposed to the action of a current of air, which enters by openings formed in the base of the stove and passes away by an outlet in the top cover. The current is taken by conductors in the usual way from the top and bottom of the battery, and is stored for use in accumulators, or it may be used direct as produced. The products of combustion pass away through a flue in the manner common to closed stoves. The working of one of these stoves is shown at the office of Messrs. W. R. Renshaw and Co., Queen Anne's-mansions, Westminster, where it is fitted up in a room about 21ft. square. The stove is about 3ft. high and 20in. in diameter, and during 24 hours will generate sufficient current for the supply of one incandescent lamp of 8 c.p. for 30 hours, or 10 such lamps for three hours. Six lamps of 8 c.p. each are supplied by it, an excellent light being given. The heating power of the stove is far above that necessary for the room in which it was placed. An important feature of the Giraud stove is the remarkable economy which is claimed for it. The fuel consumption is stated to be only 40lb. of a mixture of anthracite coal and coke per 24 hours, the cost of which is about 5d. The stove can also be run upon anthracite or coke alone. This stove has been tested by Prof. E. Hospitalier, of Paris, who reports that its E.M.F. is about 40 volts on open circuit, and over four amperes on short circuit at an internal resistance of about 10 ohms. During the day, when the current is not required for lighting, it is stored as produced in accumulators of eight cells, and the charge is regular at from 17 to 18 volts and from two to two and a-half amperes. For electro-deposition, where the voltage required is not so high as for lighting, the stove is constructed with a smaller number of elements. The stoves are made of any size or power, and can be arranged to utilise the waste heat from ranges or other heat-producing sources."

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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VII.—THE DYNAMO.

(Continued from page 457.)

The following figures are exact measurements taken from various-sized continuous-current machines for incandescent lighting: The smallest is an eight-kilowatt dynamo having an output of 80 amperes at 100 volts. There are four brushes, two being positive and two negative, the dimensions being 18cm. long by 5cm. wide by ·3cm. thick; the width of the segments of the commutators is ·5cm.; the width of the insulating strips between the segments is ·1cm. These brushes being only thin, they make contact at an angle of 60deg. instead of 45deg.; calculated out, the contact surface of each brush comes to about 3 square centimetres; each brush carries at full load 40 amperes, therefore the current density at the contact surface works out to about 13 amperes per square centimetre. For a larger machine of 40 kilowatts, having an output of 400 amperes at 100 volts, there are six brushes in all, whose dimensions in centimetres are 18 × 5·3 × ·9; the segments are ·15cm., the insulating strips 1cm., the contact surface of each brush is about 6·73 square centimetres, and at full load carries 133 amperes, and has a current density of 20 amperes. The largest machine, of 100 kilowatts, has an output of 1,000 amperes at 100 volts. Dimensions of brushes in centimetres are 18 × 5·3 × 1—12 brushes are provided; the segments are 2·8cm., the insulating strips ·15cm., the contact surface of each brush is 7·47 square centimetres, and at full load carries 166 amperes, hence its current density is 22 amperes per square centimetre. The brushes being broad enough to make contact with two segments together by bridging across the insulating strip, the circuit is not broken, since the brush touches one segment before leaving the other.

Gauze or wire brushes require to be taken out of their holders and examined every day, and, as a rule, it will be found that they will run 20 to 30 hours before they require retrimming. The contact face becomes worn to a slight curve concentric with the commutator, and when oil is used on the commutator, or when it is in a dirty condition, the brush face will have a black slimy coat of carbonised oil and grit; in any case, the face when dirty must be rubbed over with emery-cloth and brightened up. When the face is worn or burnt away unevenly, it must be filed up true, and for this purpose it is well to have a wooden block in which to fix the brush; this block consists of two pieces, both shaped at one end to 45deg., the back part has a groove cut in it just wide and deep enough to receive the brush, while the front part covers the brush, which is thus enclosed in the block. The block holding the brush is put in a vice, and the face of the brush can then be filed up perfectly true and to the right angle. When the brushes are well and regularly looked after, they very seldom require shaping with the file. All that is necessary is to clip off the fringed ends and corners with a sharp pair of scissors or shears. It is the toe of a brush that requires clipping, and the writer finds it a very good test with gauze brushes to hold them up to the light with their back towards you; if the toe is feathered out so that there is only one layer of gauze at the tip, or if it can be clearly seen through, then cut off this part, and always round off the two corners of the toe. On replacing the brushes in their holders, the greatest care must be taken to see that the contact face makes perfect contact. If the brush be pushed too far forward it will touch at the heel and not at the toe, and if it is not forward enough it will touch at the toe and not at the heel. The brush must also be put in perfectly straight, so that it lies at right angles to the length of the commutator. A lighted lamp should be provided when adjusting the brushes, so that by placing it just under them the contacts can be clearly seen and scrutinised.

When adjusting the negative brushes, which are usually *underneath the* commutators, the negative-brush cable should be disconnected, also the positive if necessary, and the rocker can then be swung right round, thus bringing the negative brushes into the place of the positive, where they can be adjusted in a satisfactory manner, and with more personal comfort. Sheet-metal brushes require scarcely any attention: simply clip off the feathered ends and wipe them with a linen rag.

Whether driving by belt or direct, always start the engine before putting the brushes down on the commutator, and never put the full load on the dynamo suddenly or altogether; have the circuit switches open, when the main switches are put on, and then as the machine takes the load, the several circuits may be switched in. Owing to the magnetising effect of the armature coils, the armature soft iron core becomes an electromagnet, one side, that which is near to the north pole of the field magnets, being of south polarity, while the other side is of north polarity. The result is that the two magnetic fields belonging respectively to the field magnets and the armature core react on each other, and where the lines of force of the first would run horizontally, those of the armature core would run vertically; but the former being very much stronger than the latter, the resultant field lies a little out of the horizontal, the lines of force being shifted round a small angle in the same direction as the direction of rotation of the armature, and since the brushes must be placed at right angles to the lines of force, hence they must be shifted forward likewise. The heavier the load the more magnetised becomes the armature core (within certain limits), consequently the more must the brushes be shifted forward. This movement forward is technically called giving a "lead" to the brushes; for full load the lead does not amount to more than, say, 15deg. beyond the vertical line, but this varies a good deal in various machines. The proper amount can only be determined by practice, and the best lead is found when the brushes are moved to a non-sparking position. As the load varies on a machine it is necessary for the dynamo attendant to shift the brushes slightly by giving them an increase of lead when the load increases, and a decrease of lead when it decreases.

When shutting down a machine, reduce the load gradually by easing down the engine, then when the lamps are almost out, or a very small current is flowing, the circuit or circuits, if several, may be opened; this prevents heavy sparking at the switches and the tendency for the engine to race. Before stopping, lift the brushes off the commutator, otherwise the brushes will be damaged in the event of the engine making a backward motion, which it often does. When the brushes have been lifted up the commutator must be rubbed with emery-cloth, a fairly slow speed being maintained; this polishes up and smoothens the commutator. After the emery-cloth, a clean duster must be applied. Waste should never be employed for cleaning or polishing the commutator, brushholder, or any such parts, neither should fluffy cloth; linen only should be used, because this does not leave any threads or fluff behind, and it wipes clean. The brushes should then be inspected, and trimmed and adjusted, if necessary. It is advisable to get all this done at once, after the machine is stopped, so that the dynamo is perfectly ready to be restarted at a moment's notice, for in central stations there is no knowing when a machine may be wanted—the load may run up, due to a fog, thunderstorm, etc., or anything occurring out of the usual, such as breakdown of a machine, etc. The commutator should be provided with a suitable covering to protect it when the machine is shut down. Lastly, all connecting wires should be examined, to see that they are firmly fixed, because terminal screw-bolts sometimes work loose due to vibration, especially in shiplighting plants; shunt coils and other fine wires leading to rheostats, regulating gear should be particularly examined, and also occasionally during running—these fine wires are not always so well fixed as the larger ones. The connecting screws being small will not stand much, and they seem to get loose more than the others.

Sparking at the brushes arises from several causes, chiefly, however, to neglected state of brushes and commutator, such as bad trimming, bad adjustment, rough commutator, etc. Some arise from the way in which the dynamo is made, and these, of course, cannot be rectified without altering the construction of the machine. The most likely causes are classed as below:

(1) Badly-designed dynamo.

(2) A badly-wound armature, giving an irregular rise and fall of E.M.F. round the commutator.

(3) Defective insulation in the field-magnet coils.

(4) Defective insulation in the armature coils.

(5) Defective insulation across commutator segments caused by foreign ingredients, such as copper dust, film of carbonised oil, grit, etc., bridging across.

(6) Rough and uneven surface on the commutator.

(7) Bad condition of brushes, defective contact or adjustment.

(8) Loose connections, terminal screws, etc.

(9) Too heavy a load for the machine.

(10) Leakage of current, due to bad insulation of the circuit or the machine, thereby causing a heavier current to flow than what is utilised.

(11) General dirty condition of commutator, brush gear, etc.

If it becomes desirable, such as through a lengthened run, to trim the brushes whilst the machine is running, one brush may be taken out at a time. The brush should first be raised off the commutator very slowly to see if the rest will carry the current; should violent sparking occur, the brush should be put down again, then if it is imperative that the brush should be trimmed, the others must be pressed down in the meanwhile.

(To be continued.)

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

The reliable information available on the subject of alternate-current transformers has until recently been very scanty. When the high-tension system of distribution, with transformers in parallel, was introduced some eight years ago, the good points of the transformers as then made were much exaggerated. It was generally stated that the efficiency at all loads was very high, and that the current taken by the primary when no lamps were on the secondary circuit was so small as to be almost negligible. This last statement may be excused to some extent when it is remembered that small currents measurement could not then be made so readily as now. Still, the engineers in charge of central stations have found that the small currents required to energise each transformer soon become a serious item in the cost of production. In consequence of their experience they now specify what the various transformers should be capable of doing, and by raising the standard of their requirements induce the makers to make further perfections.

The faults existing in the early designs of transformers may be briefly summarised as follows: Bad regulation, that is, the pressure at the secondary terminals varied considerably with the load. Hence, when the primary circuit was supplied at a constant difference of potential, the consumer found that the voltage fell as he increased the number of the lamps burning. This fault was partly overcome by increasing the primary voltage slightly when the load came on, but this does not remove the fault unless all consumers take the full load at the same hours. Otherwise, in some installations, a few lamps might be seriously overrun by the rise in pressure.

Another more important fault was the comparatively large current taken by the primary when there was no load on the secondary. This is due in a large measure to the loss by hysteresis and Foucault currents in the iron core, which in some of the early transformers amounted to from 10 to 20 per cent. of the total output. In addition to these two principal failings, there were several others in a large measure resulting from them, such as the high temperature of the transformer even when not loaded, faulty insulation between the two windings, etc.

The various makers have since that time done much to reduce these faults to a minimum, but the methods used to this end and the general practice of the design of transformers is still known to comparatively few. This is partly due to the tendency amongst many writers on the subjects to treat transformer design as a field for mathematical exercise. In this way a lot of really unnecessary mathematics is often introduced which frightens the great majority of electrical engineers.

The recent paper by Dr. Fleming, read before the Institution of Electrical Engineers in November last, formed the most practical contribution to the literature on the subject. The list given in the paper of the actual losses in some 18 different transformers is a rough guide as to what may be expected of the modern transformer. It must be remembered when examining the table, which is given below, that the transformer-makers are rapidly improving their manufactures, and hence some of the results may be already out of date. The comparison of the Ferranti transformers made in 1892 with those of 1885 will show the vast difference between the old types and those perfected by careful study.

In addition to the columns found in Dr. Fleming's table, I have added five others, showing the percentage of magnetising current and iron loss in each case, and also the figures relating to the regulation of the various transformers which are taken from other parts of the same paper. In this form the list is of great value for reference when getting out new designs.

The importance of reducing the iron loss will be seen when it is remembered that an average private house

LIST OF TRANSFORMERS TESTED BY DR. FLEMING.

∿ = 83.

Transformer.	Maximum output in watts from secondary.	Magnetising current in amperes.	Primary volts.	Power absorbed in watts at no load.	Apparent watts at no load.	Power factor.	Iron loss in per cent. of full load.	Magnetising current in per cent. of full current.	Total drop at full load in volts.	Copper drop in volts.	Leakage drop in volts.
Ferranti (1885 type)	1,875	·18	2,416	288	432	·66	15·4	23	—	—	—
,, ,, ...	3,750	·337	2,400	540	808	·68	14·6	21·6	1·6	1·9	—
,, ,, ...	7,500	·25	2,435	444	600	·74	5·9	8·1	—	—	—
,, ,, ...	11,250	·34	2,447	578	816	·70	5·15	7·4	—	—	—
,, ,, ...	15,000	·57	2,389	1,019	1,368	·75	6·8	9·0	—	—	—
,, (1885 rewound)...........	3,750	·11	2,400	233	264	·88	6·2	7·0	2·4	2·15	·25
,, (1892 type)	7,500	·075	2,400	138	180	·77	1·84	2·4	—	—	—
,, ,, ...	11,250	·076	2,400	148	182	·81	1·31	1·61	3·4	2·75	·65
,, ,, ...	15,000	·112	2,400	228	269	·85	1·52	1·79	2·1	1·65	·45
,, (1892 rewound)...........	11,250	·103	2,400	228	247	·92	2·02	2·2	2·2	1·78	·42
Swinburne Hedgehog...............	3,000	·74	2,400	112	1,775	·063	3·73	59·0	3·2	2·23	·97
,, ,, ...	6,000	1·2160	2,400	165	2,920	·05	2·75	47·5	—	—	—
Westinghouse	6,500	·05	2,400	95	120	·79	1·46	1·85	2·4	1·38	1·02
Mordey Brush	6,000	·076	2,400	140	182	·77	2·33	3·05	1·8	1·75	—
,, ,, ...	750	·0317	2,392	61·5	76	·81	8·2	10·2	—	—	—
Thomson-Houston	4,500	·083	2,400	108	199	·54	2·4	4·42	3·3	2·47	·83
Kapp	4,000	·145	2,400	152	348	·61	3·8	8·7	1·9	1·83	—

takes from five to twenty Board of Trade units per year per 8-c.p. lamp installed. If we consider a house having 120 of such lamps fixed, it might safely be supplied by the second transformer on the list. During the year it might take and pay for 13 units per lamp, or 120 × 13 = 1,560 units for the whole supply. But the transformer has 14·6 per cent. of iron loss, or wastes 545 watts continuously. Taken over the 8,760 hours in the year, this amounts to $\frac{545 \times 8{,}760}{1{,}000}$ units = 4,760 units. That means that four times the quantity paid for has to be generated. The efficiency of distribution is then $\frac{1{,}560}{6{,}320} = 24{\cdot}6$ per cent., neglecting the loss in the line Now, if the iron loss were reduced to 2 per cent., which may be reasonably expected, the waste in the iron is then $\frac{75 \times 8{,}760}{1{,}000} = 655$ units; so that, neglecting copper loss, the efficiency of distribution rises to 70 per cent.

With other consumers, such as clubs and shop-keepers, these figures will rise to a much higher value, considerably over 90 per cent. if the load is steady for any length of time.

The copper loss is important at full load, but decreases as the square of the current used, and so may be neglected at light loads. Thus, if the copper loss is 2 per cent. at full load it falls to ·5 per cent. at half-load, ·125 per cent. at one-quarter full load, and to ·02 per cent. at one-tenth of full load. Hence the regulation required does more to determine the copper loss than the consideration of the actual waste in the copper circuits.

Before going into the actual calculation of a transformer it will be well to give a short description of the fundamental principles involved. The discovery by Faraday that any change of induction in an iron core surrounded by a coil of wire caused an instantaneous E.M.F. in the wire, is employed in transformers, and the E.M.F. is made practically continuous for heating and lighting purposes by an ever-changing induction in the iron. The elementary transformer, Fig. 1, consists of an iron circuit, C, and two copper circuits, P and S, so arranged that the fluctuating current in the primary, P, causes a change of induction in the iron core, which again sets up a current in the other copper circuit, S.

It is in determining the best relative proportions of these circuits for any given result that the art of the designer has to be applied. He is always dependent on the iron manufacturer for the quality of the iron he uses, and needs to keep a constant watch by testing the iron as it is delivered. In spite of this disturbing and every altering element in the sequence of the designs, it is wrong to blame the iron manufacturer for all the faults which may occur, as is often done. The relative value of two designs is not altered much by a change in the quality of the iron used. Hence, the calculations made, if carefully recorded, together with the quality of iron assumed, have always a relative value, and can easily be altered to show the improvement made in the transformer if a better brand of iron can be obtained.

In the following investigations it is assumed that the E.M.F. curve of the alternator follows the simple sine law. This is strongly objected to by some writers, who advocate the method of taking the actual curves from the alternators with which the transformers have to be used. The published curves of alternators made in England, however, differ very slightly from the curve of sines, and the time wasted in hunting up curves and introducing the corrections from them in the formulæ would not be worth the slight additional accuracy obtained. The makers would not think of altering their stock patterns for so slight a difference in the working conditions as will be found between the E.M.F. curves of different types of alternators, and hence it is better in every way to work on the above assumption.

The E.M.F. generated in a coil of wire through which the induction is varied is equal to the product of the number of turns into the rate of change of the induction, all these quantities being expressed in absolute units. From this law it follows that in a transformer the volts as measured in a Cardew voltmeter are given for the primary circuit by the expression—

$$e_1 = \pi \sqrt{2}\, F\, \tau_1\, n\, 10^{-8},$$

where e_1 = the E.M.F. as defined above, in the primary;

e_2 = the E.M.F. as defined above, in the secondary;

F = the maximum total flux = $\mathfrak{B} \times a$;

a = the area of the iron in the core;

$\mathfrak{B}$ = the maximum induction in the core;

τ_1 = the number of turns in the primary;

τ_2 = the number of turns in the secondary;

n = the number of complete periods per second—that is, an oscillation to and fro;

10^{-8} being the coefficient which reduces the E.M.F. from absolute units to volts.

The above formulæ can be best remembered as

$$e_1 = 4{\cdot}45\, F\, \tau_1\, n\, 10^{-8} \quad . \quad . \quad . \quad . \quad (1)$$

Similarly the E.M.F. in the secondary is given by

$$e_2 = 4{\cdot}45\, F\, \tau_2\, n\, 10^{-8}.$$

Dividing one by the other we get

$$\frac{e_1}{e_2} = \frac{\tau_1}{\tau_2},$$

or, that the number of turns wound on each coil must be made proportional to the voltage required in the windings.

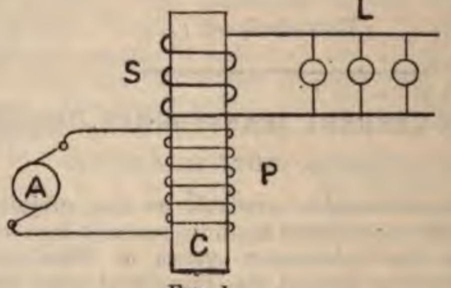
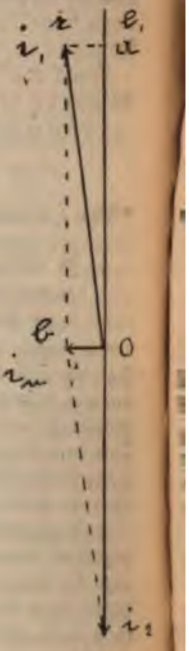


FIG. 1.



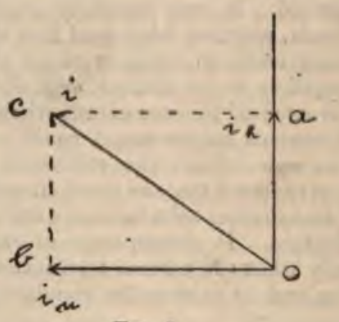


FIG. 3.

FIG. 2.

It is also seen that with a fixed frequency and number of turns, any given voltage is produced by a definite flux through the core. A mental picture of the equilibrium maintained is useful in making this clear. When the secondary circuit is open we require that the back E.M.F. in the primary shall rise to a value almost equal to the potential difference applied, otherwise a large current will pass; but a large current in the primary with the secondary open means that the core of the transformer will be strongly magnetised, and hence give a very large back E.M.F. Thus, when the magnetising current has risen to such a value as to produce the flux given by the formulæ above, no further rise is possible, as it would cause the transformer to give power back to the mains because of the back E.M.F. being higher than that on the mains.

From these considerations it also follows that the induction in the core must be practically constant at all loads, because the primary circuit is supplied at constant potential. Thus while the primary current is increased by loading the secondary, the resultant magnetising current must be the same. This is explained by the fact that the primary and secondary currents practically oppose each other in their action on the core.

Fig. 2 shows the condition of affairs when the transformer is loaded.

e_1 represents in magnitude and direction the primary voltage applied ;

i_1 is the primary current, which lags a little behind e_1 ;

i_2 is the secondary current, which is practically opposed in phase to e_1 ;

e_2, the secondary E.M.F., would be in the same line provided the external load is non-inductive.

The resultant of i_1 and i_2 obtained by the usual construction is O b, which represents the current actually required to magnetise the iron. This is here called i_μ, as the permeability of the iron determines its magnitude. Now i_1 can be split up into two components, O a, O b by projection ; of these two, O a represents the power given to the primary, and when multiplied by e_1, gives the actual power in watts.

Now when the secondary circuit is open, the only load on the primary will be that due to the hysteresis and the Foucault currents in the core. So, in Fig. 3, if we put up O a such that O $a \times e_1$ equals the watts wasted in the core, and then make O b the same as in Fig. 2, we get the resultant of these two currents in O c. The scale is larger than that in the last figure for sake of clearness. Hence O c represents the current actually taken by the transformer when the secondary is open. These two components can be calculated if the permeability of the iron and its loss by hysteresis and Foucault currents at different inductions have been obtained. The total watts lost, as obtained from the curves, are divided by e_1 to get i_H.

From the value of μ for the iron as the induction used we get by first principles that

$$i_\mu = \frac{\mathfrak{B}\, l}{\mu\, \tau_1\, 1{\cdot}76^*} \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

where l = the mean length of the path taken by the induction in centimetres ;
$\mathfrak{B}$ = the maximum induction in C.G.S. units ;
μ = the permeability of the iron at that induction ;
τ_1 = the number of turns on the primary coil.

The ratio of the current taken by the transformer at no load to the current actually required for the hysteresis has been called the "power factor" by Dr. Fleming, and this gives us the factor by which the apparent watts have to be multiplied to get the true watts wasted. For good closed-circuit transformers this factor varies from ·60 up to nearly ·90.

As regards the curves of iron losses. These should be carefully obtained for each sample of iron used in the transformers. It is possible to subdivide the loss into two—that due to eddy currents in the iron, and that due to hysteresis pure and simple. Mr. C. P. Steinmetz has worked continuously at this subject for some years, and concludes that the hysteresis losses vary as the frequency and as the 1·6th power of the induction, or $H = a\, n\, \mathfrak{B}^{1\cdot 6}$; while the Foucault currents vary as $(n\, \mathfrak{B})^2$, or $F = b\,(n\, \mathfrak{B})^2$, where a and b are constants.

The simplest way is to calculate the Foucault current loss, which, if the area is well subdivided, is not a large percentage of the whole, and then to get the hysteresis loss by subtraction. For instance, using the generally accepted formulæ, the eddy currents in a pound of iron subjected to an induction of 4,000 at a frequency of 100 complete periods per second works out to ·08 watt if the plates are 10 mils thick, and to ·18 watt if the plates are 15 mils thick. The watts loss per pound in hysteresis will vary about the region of one watt per pound, being more or less according to the quality of the iron. So that with the thin plates the eddy-current loss is under 8 per cent. of the total. It is also convenient to plot the total iron loss for a given frequency at different inductions, and it is proposed to add such a curve for reference.

(To be continued.)

---

* For $\mu = \frac{\mathfrak{B}}{H}$, and $H = \frac{1{\cdot}25 \times \text{ampere-turns}}{l}$;

$$= \frac{1{\cdot}25 \times 1{\cdot}41 \times i_\mu}{l};$$

$$= \frac{1{\cdot}76 \times i_\mu}{l};$$

$$\therefore \mu = \frac{\mathfrak{B}\, l}{1{\cdot}76\, i_\mu\, \tau_1};$$

and $$i_\mu = \frac{\mathfrak{B}\, l}{\mu\, \tau_1\, 1{\cdot}76}.$$

OVERHEAD WIRING FOR SMALL TOWNS.

BY E. H. T.

Considering the large and increasing number of small towns that have adopted overhead wiring, it is strange how little data exists as to the best methods of carrying out such work. The number of small plants designed for overhead distribution that are sent from this country to Spain, Portugal, and South America would surprise many whose lines run more in the direction of provisional orders and underground conduits.

The idea seems to be that anything is good enough for overhead work, and that it is an obsolete means of distribution which it is not worth while to improve. Perhaps, therefore, a few considerations on the subject would not be out of place, it being understood that these remarks apply especially to the countries above mentioned. The general conditions of the lighting are, of course, of the first importance. The supply of current for private lighting is usually by contract, and it is generally found necessary to cut off the light at a certain hour, say, 1 a.m., to avoid careless waste, and so diminish the price. Supply by meter in most cases would yield most unsatisfactory returns. The street-lighting is also frequently a somewhat uncertain factor. It may be switched off on moonlight nights or at a certain hour of the morning. These conditions entail separate circuits for private and public lighting, and a third circuit may be necessary in special cases for Government buildings, hotels, and such like. Some form of series street-lighting is usually adopted in such cases, small groups of high-voltage lamps being preferable to larger circuits of low-resistance lamps. There are three methods of overhead distribution: by posts in the streets, by standards on the roofs, and by wall brackets. Where the town is well laid out in squares or straight streets, it would be difficult to suggest anything better than Siemens's posts and insulator brackets. In this case the wiring presents no difficulties at all, the only question being the symmetrical arrangement of the wires, on which depends the good or bad appearance of the work. The best distance between the posts is about 35 yards. In any distance beyond this the sag becomes unsightly and increases rapidly. If it is found convenient to run secondary mains from transformer sub-stations the mains should be tapped at a post, and not in mid-air, as is frequently done, and the wires carried to two insulators at right angles to the mains, and from thence enter the house. A fuse, consisting of a strip of porcelain with two terminal screws, can here be inserted between the main and the insulator. This fuse is exposed to the weather without giving any trouble. It may happen, however, that it is impossible to run posts either on account of trees or the narrowness of the streets, or, still more likely, on account of the expense where the crookedness of the street rendered a great number of posts necessary. In this case the choice lies between roof standard and wall bracket. The Spanish type of building is peculiarly suited to roof standards, having a flat roof and parapet, and where these conditions exist roof standards should always be preferred to wall brackets for cheapness, security, and better appearance. Moreover, the wires can enter the house from the back, which is preferable to entering from the front. The appearance of this kind of wiring depends greatly on the design of post or standard, and the height at which it stands from the roof. Two short cross-bars are better than one long one, and the posts should not be higher than safety demands.

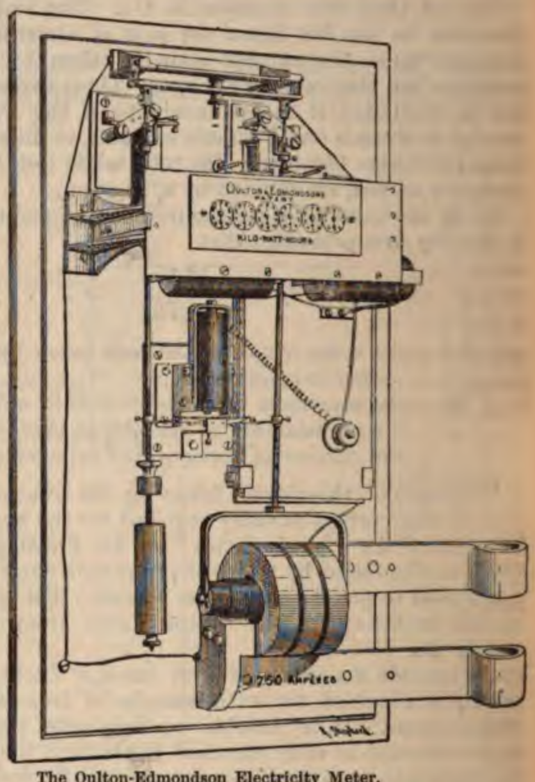
On the other hand, the Portuguese house is steep-roofed, and without a parapet, which makes it unsuitable for this kind of distribution. It is in this case that the wall bracket may be adopted for low-tension circuits, but it is not advisable to run high-tension wires in this manner unless they are placed far beyond reach of window or balcony—an almost impossible condition. Provision for high tension mains can be made by posts and house-posts without keeping to the line of the streets. The best position for brackets is just under the balcony cornice. As the cornice is higher or lower, the wires should be raised or lowered accordingly, so that they always run parallel, and at the same distance from the cornice of each house. In this way the effect is not so bad. The insulators on the brackets need not be more than 3in. apart, as in any case a large number of brackets must be used, and the spans are very short. When there are both a parallel and a series circuit, the parallel should be run first and the street circuit afterwards. Where a street circuit only is to be wired up, each post or bracket must be guyed back, and the guy not removed until the next two posts or brackets are finished.

THE OULTON-EDMONDSON ELECTRICITY METER.

We have already described this meter, which in its improved form presents several novel and satisfactory features. Though electricity meters of the double-pendulum type have long been in use, their more extensive adoption has been prevented by the following important defects—viz., the synchronism of the pendulums was extremely difficult to maintain; the clockwork required winding up at short intervals; the measurement was proportional only through a very small range. In the Oulton-Edmondson meter these objections are claimed to be entirely eliminated. The synchronism is perfect; the pendulums are driven without clockwork; the measurement of the current is proportional throughout any range.

The Oulton-Edmondson meter consists of two pendulums, each driven (without the intervention of clockwork) by a small impulse arm, acting on the pendulum by the force of gravity, and lifted at each double vibration by an electromagnet. As a timekeeping arrangement this is superior to anything heretofore known, all friction having been eliminated except that of the very fine pivots on which the impulse arm moves as its centre. Electrically-driven pendulums are no novelty, but they have lacked precision, as the varying force of the current gave a varying impulse, and even when a gravity impulse arm was used the friction connected with the locking and unlocking of the arm after it was lifted by the electromagnet introduced considerable inaccuracy. In the Oulton-Edmondson arrangement there is no locking or unlocking, and the impulse given to the pendulum being dependent on gravity alone, and practically free from friction, is absolutely constant, hence its excellent timekeeping qualities. The synchronism of the two pendulums is ensured not alone by their accurate timekeeping.

Advantage has been taken of the well-known principle that two bodies, having the same period of vibration, will vibrate in unison if connected together by any medium which can convey the vibrations from the one to the other. The two pendulums, instead of being hung from a rigid support, are both suspended from one bar, which is itself suspended by stiff springs. The bar thus becomes the medium by which the vibrations of the pendulums are kept in unison, so long as no current is being consumed. As soon, however, as the flow of current through the main coils alters the period of the one pendulum (as hereafter described) it is "out of tune," as it were, with the other, and is free to register the current as required. The motion of the synchronising bar is so slight that it can only be seen by a very powerful magnifier, yet it perfectly accomplishes its purpose of giving stability to the synchronism of the pendulums. The impulse arm forms part of the circuit of the electromagnet which lifts it, and the circuit is closed by a projection from the pendulum coming in contact with the arm. The points of contact are of iridio-platinum, and are protected from sparking by a condenser and a resistance coupled across them. This arrangement prevents sparking. There is a slight deposit of very fine dust near to the contacts, apparently collected by the static charge, but the surfaces actually coming in contact remain perfectly bright and clean. This feature is as interesting as it is important. The working of the two pendulums in a 100-volt meter takes only ·01 ampere. The "volt coil" of the registering pendulum vibrates within the main coil (see illustration), and is in the same high-resistance circuit as an electromagnet placed between the pendulums. When the supply is switched on, this magnet lifts two small arms and releases the pendulums, which commence to vibrate, and continue doing so until the switch is again opened, when the two arms engage the hooks on the pendulums and hold them so long as the supply is interrupted. The current through the circuit of the volt coil and of this electromagnet in a 100-volt 50-ampere meter is ·01 ampere. Thus it will be seen that the total consumption of current for maintaining the action of the meter is ·02 ampere. Current going to the lamps passes through the main coil, and acting upon the volt coil of the pendulum quickens the speed of its vibration. Such variation from the speed maintained by the other pendulum is registered on the dial which thus indicates the current consumed. The loss of potential of the current under measurement is inappreciable. The two currents passing through the main coil and the volt coil would not, by themselves, give proportional readings, for the force required to produce the vibrations of a pendulum is in proportion to the square of the number of vibrations. If, therefore, a = the normal number of vibrations, and b = the number to be added by the current, the force required to produce a will be a^2, and to produce $a + b$ will be $a^2 + 2ab + b^2$; the difference $(2ab + b^2)$ being the force to be exerted by the current under measurement. With the volt and main coils alone, the force actually exerted would be in the ratio $2ab + b$ only. Upon each volt coil therefore there is wound a "correcting coil," carrying a very small proportion of the current passing into consumption. This small current brings the ratio up to $2ab + b^2$, and makes the reading proportional throughout any range.



The Oulton-Edmondson Electricity Meter.

Though this meter is claimed as the most accurate extant, it is not a delicate instrument, but is thoroughly adapted to all the requirements of electric supply companies, whether for house supply, charging accumulators, or registering the output of the generators. The engraving is taken from one for 750 amperes, made for central-station work, by Mr. Joseph Edmondson, Albert Electrical Works, Hey-street, Manchester. The meters are made for currents of 25 up to 1,000 amperes.

REVIEWS.

Die Berechnung Electrischer Leitungsnetze in Theorie und Praxis. (The Calculation of Electrical Distributing Systems.) By JOSEF HERZOG and CL. P. FELDMANN. (Julius Springer, Berlin.)

The present volume, just issued from Budapest and Cologne, will certainly be found a great boon to all who are able to read it in the original. The problems of distribution are discussed with the most elaborate thoroughness under all the conditions likely to arise in practice, and special chapters, with a concise but interesting historical account of development, are given to installation, the heating of the conductors, the incandescent lamp, the arc lamp, rheostats, cut-outs, etc. No extensive previous technical or scientific education is assumed, and the formulæ, dealing first with the simplest cases, are gradually increased in complexity, and the whole course of exposition is greatly aided by diagrams and graphic representation. Nearly 60 pages are devoted to discussing the heating of conductors, and tables and calculations to meet every case and every kind of conductor are given. Occasion is taken to point out some inconsistencies of the stipulations of the Board of Trade with respect to the diameters of the wires in small and large installations.

The problem of the yearly loss of energy in a cable is discussed at considerable length with reference to an example from Frankfort-on-Main: "When we wish to ascertain the loss of energy due to a variable current, i, flowing during the course of a year through a cable of resistance, R, it is necessary to determine the value of the integral $\int i^2 dt$. But it will be sufficient for our purpose to assume that in t_1 hours of the whole period, T, the current i for n_1 normal lamps, in t_2 hours of the whole period, T, the current i_2 for n_2 normal lamps, in t_3 hours of the whole period, T, the current i_3 for n_3 normal lamps flows through the cable. The total loss of energy is then $R(i^2 t_1^2 + i_2^2 t^2 + i_3^2 t_3 + \ldots.) = Ri^2(n_1^2 t_1 + n_2^2 t_2 + n_3^2 t_3 + \ldots.)$, and the part in brackets will correspond to a fictional strength of current, J_N, for N lamps, which may be found from the equation—

$$J_N{}^2 T = i_1^2 t_1 + i_2^2 t_2 + i_3^2 t_3 + \text{etc.}$$

Put $\Sigma (i^2 t) = i_{\max} \; \Sigma \left[\left(\frac{i}{i_{\max}} \right)^2 t \right]$, and let t be taken for one hour, and ascertain the proportion of the current in each hour to the maximum. The proportion $\left(\frac{i}{i_{\max}} \right)$ may be obtained approximately enough by comparison with results of places where similar conditions prevail." An elaborate table is here given showing the ratio of the current to the maximum for every hour of the 24th December, and for the averages of the days of the winter and summer months respectively. "For simplicity, the maximum current, $i_{\max}$, for 21,000 normal lamps is assumed as the unit, and we obtain the result—

$$\Sigma \left(\frac{i}{i_{\max}} \right)^2 t = 400 = J^2 T_N = J_N{}^2 T.$$

Take $T = 24 \times 365$, then $J_N = \cdot 22$.

It is to be observed that the calculation of the loss of energy depends on a more or less approximate estimation, so that it seems advisable in practice somewhat to increase the section that would be given by calculation as the most economical."

The book contains 360 pages, and, though it introduces nothing absolutely new, may be taken as a very complete text-book of electric light distribution, with a clear grasp both of theoretical and practical conditions, and so far up to date as to embody valuable results even of the last six months.

Anordnung und Bemessung Elektrischer Leitungen. (The Arrangement and Calculations of Electrical Conductors.) By C. HOCHENEGG, chief engineer to Siemens and Halske. (Julius Springer, Berlin.)

The above traverses to a considerable extent the same lines as the work of Messrs. Herzog and Feldmann, but as it deals less with the theoretical basis of the subject, and more particularly with the engineer's actual business installations, it may be taken rather as supplementary to the former text-book. The contents are arranged under three main headings: I. The security of the whole system of distribution. II. Its efficiency in technical regard. III. Economical considerations.

The first division occupies only the first 16 pages, but there is an appendix given in which is set forth the list of instructions for safe working drawn up by the Electrotechnical Society in Vienna. These treat separately, and with great particularity, of the generating machines, the conductors, and the subsidiary apparatus, and lamps, and are certainly a very complete body of practical directions. About 40 pages are given to the discussion of various examples of current distribution, and, in addition to the usual formulæ, the graphic method is employed, not only for illustration, but also for calculation. The main body of the work, which contains less than 200 pages, is taken up with the practical discussion of the influence of economical considerations upon the systems of electric distribution.

The separate factors are considered in turn, and discussed with respect to their first cost, durability, repairs, etc., and a table is given showing the relative expenditure on different objects of the plant.

Another table shows the statistics of hours of working for the lighting of large and small towns, under different conditions. Various practical cases are then dealt with in order: Incandescent lamps in series, arc lamps in series, electromotors in series, influence of distance as compared with cost of plant and working, etc.

Finally, there is a comparison of the three-wire system, the five-wire system, and the alternate-current system. "With equal perfection and practical convenience of the different systems, one would give the preference to that which best satisfied the considerations of economy. But it is here necessary to take into account not only the prevailing conditions of the industry, but also to consider how these are likely to be modified in the future. Without going into other advantages and disadvantages of the separate systems, we will investigate, under conditions as near as possible similar, the cost of distribution, etc., of the three-wire system, the five-wire system, and the alternate-current system, and this for various distances between the central station and the centre of the district to be served."

Various elaborate tables of costs are given, and a graphic representation of the variation of cost with the distance from the generating system.

"So one gains a view how the costs of the various systems are made up, and in what points improvements may be aimed at in order to bring about further economy. We observe from the figures that with the present conditions of the industry, the three-wire system is best up to about 1,200 metres, but after that point is excelled by the five-wire system. The latter is then the best up to a distance of 3,000 metres, but must then give way to the alternate-current system. In the improvements to be expected in the future the yearly cost of the three-wire system will sink 25 to 42 per cent., that of the five-wire 18 to 30 per cent., while the cost of the alternate-current system will remain unaltered. Accordingly, in the future the five-wire system will be the most advantageous from 1 to 4½ kilometres (say, three-quarters to three miles)."

INSTITUTION OF ELECTRICAL ENGINEERS, May 11.

The following candidates were balloted for:

Foreign Member.—E. M. Kal, Assistant Inspector, Government Telegraphs, Batavia.

Associates.—William Blenheim, Egham, Surrey; George Alfred Brade, Engineering Department North Staffordshire Railway, Newcastle-under-Lyme; John Edward Neale, Engineering Department, North Staffordshire Railway, Stoke-on-Trent; Thomas Joseph Rorke, 104, Fulham-road, West Brompton; Thomas Crewe Wolley-Dod, Edge Hall, Malpas, Cheshire; Charles Townsend Young, 15, Bedford-place, London, W.C.

Students.—Arthur Edward Bennett, Bella Vista, Leigham-court-road, Streatham, S.W.; Maurice Hollinshead Brady, Larkhill House, Stockport; Herbert Lant Viret Carpenter, 13, St. Albans-road, Willesden, N.W.; Edward MacGregor Duncan, Glenavon, Napier-road, Redland, Bristol; Charles Alfred Hopton, Ulverstone, 179, Tulse-hill, S.W.; Joseph Sperati, Rosa Alba, Highbury-park, N.

The paper by Mr. W. B. Sayers, as previously announced, was then read.

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PROBLEMS FOR CHICAGO.

No doubt the inherent difficulties of the subject prevented Prof. S. Thompson from doing more in his paper to the Society of Arts than providing a somewhat tantalising text. We hold that a large part of the problems put forward in this paper have no more to do with a congress of electricians at Chicago than they have to do with a congress of schoolmasters on lunar eclipses. We expected better things of Prof. Thompson. He is not usually imbued with strict professor-isms, but is apt to kick over the traces and view things in a broader spirit. What has a congress to do with high or low pressure, with direct-driving as against belt or rope driving? Does Prof. Thompson imagine that practice in electric lighting can be restricted to a few circumscribed plans, all described within the covers of a little book or a big book, and that all one has to do, when it is desired to put down an installation is to take out the book and go to work? His contention, and the contention of those who hold his views, seems to be that in all cases there is but one best way, and that no circumstances can modify that one best way. At Chicago the electricians met in solemn conclave are to decide between belt-driving and direct-driving, and ever after the one condemned is to be relegated to the realms of oblivion. Similarly, it might be argued there is but one right type of dynamo, of alternator, of motor, and only one right way of distribution. Well, that may be argued till doomsday, but practice won't follow and be restricted to one type. From the standpoint of Prof. Thompson we ought to have but one type of locomotive, and engineers ought to have decided at some long since held congress what this type should be. But they haven't, nor are they likely to do so, because they know too well that the old adage still holds good and that circumstances alter cases. American practice may never conform to English practice, and we are quite sure that if an American town wants electric light to be running in a fortnight it must take the component parts from stock, and must not expect that every part will be the best that could be designed for the position. The questions proposed are not questions for a congress. Let the electricians gathered together who are so fond of talkee-talkee restrict their discussion to questions relating to definitions, to units, to methods of teaching—broadly, to notation and nomenclature. Their work in this direction is often puzzling enough and injudicious; for another congress but undoes the work of a previous one, and so there is a perennial stream of change always ripe for discussion. As soon as theorists trespass upon the field of practice, so soon do they get inextricably mixed, their doings giving rise to laughter and their conclusions ending in smoke. For example, the practical man does not care one jot whether thepractical unit of resistance—the ohm—be the resistance of 100cms., or 103cms., or 105cms., or 110cms. of mercury of a certain sectional area. What he wants is a workable unit, easily made and compared, and unchangeable. What the theorist wants is a practical unit that shall conform most nearly to a theoretical one, be the length 106cms., or 106·3cms., or 106·34cms., or correct to the third or thirtieth place of decimals. In 90 per cent. of cases we do not believe resistances are measured correct to even the first decimal point, and in the great majority of cases it doesn't matter whether they are or not. We do not mean to be flippant on this question, or to treat it as unimportant; merely to point out that the practical man is not moved by the same considerations as the theoretical man. To us Prof. Thompson's problems seem to deal mostly with methods of practice, and with these, we say, the congress has no business and cannot effectively deal. Messrs. Crompton, Garcke, and Siemens could do more in ten minutes to decide some questions of practice than the congress at Chicago could if it sat for ten years.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC TANNING.

SIR,—I note in your issue of the 5th inst. a letter from Mr. Groth, in which he criticises the methods of experiment employed by me, and described in the paper which I read a short time ago before the Institution of Electrical Engineers, on the "Influence of Electricity in Tanning Operations." In reply to this, I should like to make a few remarks on the following passages, in which Mr. Groth says that some figures, and also some statements, I have there made are "wrong" and "inaccurate."

Mr. Groth says: "As to the 'final result,' Mr. Falkenstein continues to say, 'it has been established by Messrs. Rideal and Trotter . . . and Dr. Zerener, that a saving of time from 4 to 38 per cent. is obtained,' which would most likely be understood to mean that Messrs. Rideal and Trotter's experiments would show 4 per cent., and Dr. Zerener's 38 per cent., whilst, in reality, it should be the very reverse; but even then the figures are wrong, as they ought to be 83 per cent. . . ."

The passage in question, as it appears in the *Journal* of the Institution of Electrical Engineers, vol. xxii., p. 229, reads as follows:

"The final result has been established by the experiments of Messrs. Rideal and Trotter, Prof. Müntz, of Paris, Dr. Foelsing, Dr. Zerener, and others—viz., raw hide is capable of combining with its equivalent weight of tannic acid in from 4 to 38 per cent. (according to the process employed) of the *time taken* when electricity and apparatus, or electricity alone, is not applied."

On comparing the two, it will be seen that Mr. Groth has substituted "saving of time" for "time taken," which entirely alters the sense of the passage, the "time taken" by the several electrical processes, expressed as percentages of the time taken when working in pits without electricity, being obviously quite a different thing from the "saving of time" effected by the use of electricity in any electrical process, compared with the old system. I may add that the 4 per cent. refers to the Worms and Balé process (electricity and apparatus), and the 38 per cent. to the Landin and Abom process (electricity alone), that of Mr. Groth standing at 17 per cent., taking Mr. Groth's value for the "saving of time" in his process as 83 per cent.

Later on in his letter Mr. Groth accuses me of the use of "statements loosely made," and bases his charge on the above, and also on the following—viz., that in giving an outline of the Worms and Balé process, I did not mention that turpentine was used therein. Now, turpentine is used in that process in small quantities to prevent oxidation and fermentation of the liquors, in the same way that other antiseptics are used in tanning under the old system, but its use in that connection in the Worms and Balé process is no more an essential feature of that process than the use of "patent antiseptics" of various kinds is to the process generally employed by tanners in this country.

I think that the above will be sufficient to show that Mr. Groth has possibly been somewhat hasty in reading the paper and forming his conclusions thereon.—Yours, etc.,

CONRAD K. FALKENSTEIN.

London, May 8, 1893.

CONNECTING COMPOUND DYNAMOS.

SIR,—I have read Mr. Guy's excellent article on above in your issue for April 21. Will he kindly say what modifications he would make if he could not alter the speed of his machines on starting and switching out, being driven, say, from a countershaft running at constant speed?

In the diagram on page 410, if a switch is placed between negative terminal and omnibus bar, and the one on "equaliser" done away with, will they work satisfactorily?—Yours, etc., YOUNG ELECTRICIAN.

ELECTRICAL PUMPING PLANT.

An installation of electrical pumping machinery has just been designed and fixed by Messrs. Easton and Anderson, Limited, 3, Whitehall-place, S.W., and Erith Ironworks, Kent, at the brewery of Messrs. Warwick and Richardson's, Limited, Newark-on-Trent, which possesses several features of interest. Mr. J. F. Warwick, in seeking, on behalf of the company, for an independent supply, found, about a year ago, a source of water suitable for brewery purposes by sinking a well in a field about a mile and an eighth from the brewery, and at the same time conceived the idea of pumping up this water by means of electricity to the tank at the top of the brewery, generating the current at the same place, and transmitting it to the pumps by suitable conductors. Accordingly, he placed himself in communication with Messrs. Easton and Anderson, Limited, who undertook to carry out the work, and received the order from the company in September last for doing so. The question at once arose: Should the conductors be overhead or underground? It was manifestly better that they should be underground, as it avoided the use of unsightly poles and wires, which would be more liable to injury, though, of course, more accessible for repairs. The cost of underground cables suitable for the purpose appeared at first sight, however, to put them altogether out of court.

There was, however, one circumstance in which this work differed from the ordinary electric transmission plant, and that was, that a water-pipe had to be laid to the brewery from the well, and this involved getting out a trench. It occurred to Messrs. Easton and Anderson that if a pair of cables could be laid in the trench at the same time as the pipe, the cost would be very materially reduced, and on going into the matter it was found that while the plan would not be cheaper than posts and naked overhead conductors, it was not very much dearer; so that it was eventually decided to use the underground system. It was thought at one time that the pipe main might have been used for a return instead of a second cable, but the idea was not acted upon. It was considered desirable to be able to automatically vary the speed of the motor by varying that of the engine, and this condition was easily fulfilled by making the dynamo and motor both series wound.

The plant now stands as follows: The dynamo is of the "Whitehall" type, having slotted armature and double magnetic circuit, the field magnets being of cast iron. It is, as before stated, series wound for 360 volts and about 1·5 amperes at 900 revolutions. It stands on sliding rails, and is driven by a link belt from a countershaft which derives its motion by a belt from a horizontal single-cylinder non-condensing engine, which, with the countershaft, was already in existence. At present this engine does very little other work, but as it is too large for the pumping, it is contemplated to use it for other purposes, and therefore the pulley on the countershaft which drives the dynamo is fitted with a friction clutch, which enables the dynamo to be readily started or stopped as required, independently of the engine.

Suitable fuses and cut-outs are provided in the engine-house, and from them the cable is led to the pumps. An ammeter is also fixed here so that the engine-driver can see that the current is being properly supplied. The cable was made by Messrs. Callender and Co., and is of their armoured type, so that it cannot easily be injured as it lies in the ground. The conductor consists of seven wires, each ·054in. diameter, giving a total sectional area of 0·0155 square inch, and a maximum resistance of 2·84 ohms per mile, insulated by means of a solid sheet of vulcanised bitumen, taped and secured with jute yarn, armoured by means of 20 galvanised iron wires, and finished by a braiding of hemp yarn well compounded. It is laid in a special trench for a short distance till it joins the delivery-pipe main leading to the tank, and from thence the two go together to the pump-house, at a depth of about 2ft. below the surface of the ground. There are only two joints on each of the two cables, and as the workmen laid the pipe they laid the cables, one on each side in the trench, leaving the part to be jointed open till the work was done, when a special man was sent by Messrs. Callender, who made the joints and tested the line. The pipe main consists of 5in. cast-iron socket and spigot pipe, for the most part jointed in the ordinary way. At one point the pipes have to cross a railway bridge over a canal, and here—in order to occupy as little space as possible—they are of wrought iron with flange joints, and are made only 4in. diameter, carefully enclosed and lagged to keep them from the effects of frost, the cables also being included in the same casing to preserve them from injury. The ground is low and wet, and the pipes and cable in some places pass under ditches, and were then actually laid below the water-level.

The pump-house is situated a few yards from the well. The outlet from the rising main at the tank is 70ft. to 80ft. above the surface of the water in the well. The pumps are of the ordinary three-throw type of Messrs. Easton and Anderson's standard pattern, with gunmetal valves. The barrels are 5½in. diameter and 12in. stroke. The pump crankshaft is driven from a countershaft by means of a cast-iron pinion and wheel; and the motor in its turn drives the countershaft through the medium of a gunmetal pinion and a mortice wheel, the teeth of which are accurately machined to a special shape. The motor is fixed on a concrete foundation, in such a way that it is readily accessible on all sides, which is a very desirable thing where space permits. It is of the same type as the dynamo, and is likewise series wound to run with 260 volts at a speed of 600 revolutions—at which the pumps will make 28 revolutions per minute, and are calculated to deliver 5,000 gallons per hour to the brewery. The bearings of the motor are made self-oiling by having each brass bush made in two lengths, with a gap between them, in which an endless pitch chain of brass rests on the spindle, and dips into an oil-well beneath the bearing. When the spindle rotates, it carries the chain round, and brings up a supply of oil, which is deposited on the spindle, and finds its way along the bearings by means of grooves, eventually returning from the outer ends of the bearings to the oil receptacle. Thus, the motor may run for weeks, or even months, without any attention to the lubrication being necessary. The lubricators on the pump are of the ordinary needle type, which last a considerable time without attention. For stopping and starting the motor at the pump-house, a suitable switch and resistance frame is provided.

THE LIGHTING OF RAILWAY TRAINS.*

BY OSWALD HAES, M.I.E.E.

The question of the proper lighting of railway trains is one which appeals to the whole of the travelling public, who now form a very large section of the community. The managers of all well-conducted railway lines now fully recognise the necessity of making travelling by train not only cheap but comfortable, and much has been done of late years to attain this end; but while a large amount of attention has been given to the provision of sleeping and lavatory accommodation in the cars, very little appears to have been done to provide that one desideratum to the traveller—a brilliant, steady light. Those who do much travelling know well how the tedium of a long journey is relieved if the long hours between sunset and time for retiring is spent in reading. A few years ago a good light in a railway carriage was looked upon as a luxury too great to expect, but many things that were regarded as luxuries when railway travelling was first introduced are now insisted upon as necessities, and it is quite time that all railway carriages were provided with the means of enabling people to read at all times, and the object of this paper is to show how this bright, steady, and perfectly safe light can be provided by means of electricity, and to describe the plant now in daily use for the purpose on a train.

The pioneers of electric lighting in railway trains were Messrs. Stroudley and Houghton, and the first train so fitted was run on the London, Brighton, and South Coast Railway between Victoria and Brighton in the latter part of 1881. Since that time this company has largely extended this system, and have now between 20 and 30 trains so fitted, while latest advices from England inform us of another very considerable extension being carried out. Nearly all the railway companies on the Continent and in America have since fitted at least one experimental train, and some of them have gone considerably beyond that stage, and have now many trains fitted with the electric light. In England alone there were in May, 1891, according to Mr. Langdon, of the Midland Railway Company, 365 coaches and 57 vans electrically lighted, since which the number must have greatly increased. There are several methods of fitting trains to be lighted electrically, each of which has many points of interest, and its own special advantages, but as it is impossible within the limits of this paper to fully describe them all, the author proposes to enumerate the different systems shortly, and to describe in detail the one which he has been engaged in introducing and putting into practice in these colonies. 1. Accumulators only, placed either all in the guard's van in one large battery, or in small batteries in or under the coaches. In the latter case each coach is self-contained with its source of supply. The cells are then charged at the terminus, there generally being a duplicate set so that one is being charged while the other is in use. This was the method used in fitting up the first trains. 2. Accumulators in conjunction with a dynamo, the latter being driven either from the axle of the van or by a separate steam-engine fixed either in the brake van or on the locomotive. The former method is the one mostly in use in England and on the Continent, while the latter is the one most favoured in America. With either method of driving the accumulators may be either all in the brake van or in the separate coaches. Under this head is classed the system devised by Mr. Langdon, the electrician to the Midland Railway, for the lighting of trains that are broken up on the road. He places a small battery of accumulators under each car, and connects them up in parallel for charging from a dynamo fixed in the guard's van and driven from the axle. When the train is in motion the light is supplied from the dynamo, but when standing still the cells supply the current, and a carriage may be disconnected and it carries its source of light with it. 3. A dynamo driven by a small engine fixed either in the van or on the locomotive, no storage being used. The objections to this method are obvious—viz., that the lighting is entirely dependent on the engine and dynamo, and consequently it has not been used very largely, though from a point of economy in first cost and maintenance, the small engine and dynamo fixed on the locomotive have many advantages. 4. Primary batteries have been tried, but were long since abandoned; the same fate has befallen a novel idea suggested by Mr. W. H. Preece in 1883, which was for employing the movement of the train to compress air in a chamber and of using the gas so compressed to drive, by means of an air-engine, a dynamo for lighting the train. 5. Another system which, perhaps, rightly comes under the first heading, though it is really for providing a light to the individual and not to the whole carriage, is the system being brought into use on some of the underground railways in London. Small accumulators are fixed on the wall of the compartment, just above the head of the passenger, and an incandescent lamp of 2 c.p. or 3 c.p. is fixed in a kind of lantern on the front of the accumulator-box, and is arranged so as to throw all the light on the position in which a person would naturally hold a paper or book when reading. The light is started by dropping a "penny in the slot," which action closes a switch and starts a train of clockwork, which at the expiration of 30 minutes switches the light off again. A switch is also provided on the outside of the box so that the light can be turned off on leaving the train, and the lamp can only be lighted again by the insertion of a penny. In one feature this apparatus differs from the majority of the penny-in-the-slot machines, inasmuch as when the accumulators are discharged and can give no further light it absolutely refuses to take the coin. The accumulators are removed at regular intervals and replaced by full ones.

The system in use on the Glasgow Metropolitan Railway differs from any of the above, but has not come into general use. In this case there are a number of tunnels along the line, and for providing light during the day in these tunnels a third rail insulated from the ground is laid in the centre of the track, extending a few yards beyond either end of the tunnel, and is connected to one pole of the dynamo, the ordinary rails being connected to the other. The coaches carry a contact-arm with a collecting brush, which, on coming in contact with the third rail, closes the circuit through the lamps; in that way the lamps are lighted and extinguished as the train enters and leaves the tunnel.

Some months ago the Railway Commissioners of South Australia expressed a desire to have an experimental train fitted up with the electric light, and after some parleying a contract was signed with the Brush Electrical Engineering Company, notwithstanding the severity of the conditions proposed by the commissioners, which may be briefly stated as follows: The train was to consist of six ordinary carriages and brake van, all bogie stock; it was to be a through train, not one broken up on the road. The plant was to run for six months continuously as an experiment, and if the light failed six times in that period, the commissioners had the right of refusing the acceptance of the plant, the company in that case having to stand the whole of the cost of the experiment. On going carefully into the matter it was decided that the only way of conducting the experiment successfully was to adopt the system which had proved so successful on the London and Brighton and other lines in England—*i.e.*, the axle-driven dynamo in conjunction with accumulators.

Description of the Plant.—The dynamo is of the ordinary Brush pattern, wound as a shunt machine, and is too well known to need description here, Fig. 1. The commutator is also of the ordinary pattern, but with the spaces between the segments filled up with mica. The brushes are made of a sheet of copper wire gauze about about 1½in. wide folded backwards and forwards on itself to about 2in. thickness, the fold being about ⅜in. wide, and are held together with copper pins passed through them and riveted over. The brushes are held radially on the commutator, the three-eighths side bearing on the segments by being enclosed in a small rectangular brass box, and the requisite pressure is obtained by spiral springs acting vertically on the brush. The adjusting screw is provided with a lock nut to prevent the spring slackening back with the vibration. The ordinary flexible wires are used for the connections to the brushes, the ends of the wires are sweated into the end of in the same direction—sufficient pressure being put on them to allow of them gripping the commutator for that purpose—the switch lever is operated at the same time and the connections made as required. Stops are, of course, provided to prevent the rocker moving too far.

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* Abstract of paper read before the Electric Club of New South *Wales, February 3,* 1893.

Driving Gear.—In England, where fixed wheel stock is exclusively used, the question of driving the dynamo by means of a belt from the axle is a comparatively easy matter, but with bogie stock as used in America and in these colonies, the question is one of much greater difficulty. In a paper read by Mr. A. H. Bauer before the American Institute of Electrical Engineers, in June last year, he said, "Several attempts have been made to drive dynamos by connection with the axle of bogie trucks. All, however, have failed, for the reason that no provision was made for maintaining the armature shaft and axle parallel at all angles of the truck, and because sand, dirt, etc., gathered by a moving truck, will soon destroy any mechanism that may be used for the purpose under the car. The problem, however, has not been abandoned, and I am in hopes that within a very short time a solution will be found." At the very time that that statement was being made the author was engaged in fitting up the present plant in South Australia, and looks forward with interest to hear shortly if Mr. Bauer has found another solution. In dealing with this question here, it was at first intended to use a method of driving that provided for the dynamo and axle being kept parallel, but it was soon seen that there were insurmountable difficulties in the way, and the method at present in use was adopted, and the excellent way in which it has worked continuously for the past four months proves that if it does not completely solve the problem, it goes a long way towards doing so. The general arrangement is shown in Fig. 3. A is a flanged pulley fixed to the axle of the bogie truck; B B are flanged guide pulleys arranged to slide above the dynamo pulley in a vertical frame fixed firmly to the floor of the van; C C are spiral springs, with their lower ends fixed to screws, the nuts of which are fixed to a cross frame bolted to the slides. The pulleys, B B, are carried by the springs, and are adjustable in the slides by means of the screws. The dynamo is lined up with the bogie axle, with the van on a straight line, and is bolted firmly to the floor of the van directly over the axle. The driving pulley on the dynamo is also flanged, as is shown at D. The belt, which is preferably of the leather link pattern, passes under the axle pulley, A, over the guide pulleys, B B, and under the dynamo pulley, D. Now, it is evident that any deflection of the bogie axle from the parallel means a depression of one or other of the guide pulleys according to the direction in which the axle moves, and the spring under that pulley becomes compressed, and the driving tension on the belt is maintained constant. The springs, C C, further serve to compensate for the depression and extension of the carriage and bogie springs, which are constantly varying quantities on a running train. All bearings, both of dynamo and guide-pulleys, are provided with large lubricators sufficient to hold a day's supply of oil.

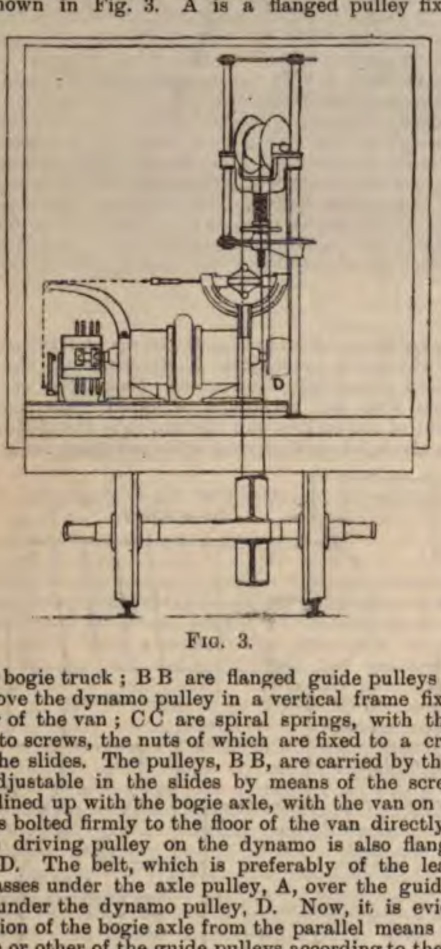

Fig. 3.

Accumulators.—These are of the E.P.S. type, the sections being enclosed in lead-lined teak cells; 24 of the 23-plate size are used, and are placed in tiers behind the dynamo at one end of the brake van. The van is amply ventilated, and thus all danger from a possible explosion of accumulated hydrogen is avoided. The accumulators might be placed under the floor of the van between the bogie trucks, and in future sets probably will be.

Instruments and Regulating Apparatus.—A switchboard is fixed on the partition adjoining the guard's compartment at the end of the van, in a convenient and handy position. It is provided with the following instruments shown in the diagram of connections, Fig. 2, in which the main current circuits are represented in thick lines, and the shunt and smaller currents circuits in thin ones; the voltmeter connections are shown in dotted lines. Magnetic ammeter, A, with the zero in the centre of scale, so that the deflection of the needle indicates the direction of the current as either to and from the cells. This is connected up so as to show the current in the lamp circuit whether supplied by dynamo or cells, and when the lamps are not on, the current passing into the cells. Magnetic voltmeter, B, provided with a two-way switch to allow of the difference of potentials between the lamps, cells, and dynamo terminals being observed. Main-circuit relay and resistance switch, C. This is wound with a thick wire connected to the main dynamo circuit. An armature pivoted above the coil carries on its other end a contact-piece, which in the normal position short-circuits two strips of copper, C_1 C_2, across which a suitable resistance contained in an iron frame, D, is connected. When the relay becomes energised by the main current from the dynamo, it draws down the armature and opens the circuit through the resistance which is in the lamp circuit. The E.M.F. of the dynamo being necessarily higher than that of the cells, this resistance must be inserted when the dynamo is supplying the lamps, as otherwise they would be brighter than when supplied from the cells. A regulator, operated by hand, is provided at E, to enable more or less resistance to be put in according to the number of coaches on the train.

Field Relay Switch.—F. This little switch is in circuit with the field-closing relay, H, and between the solenoid of the magnet and the + pole of the cells.

Main and Field Resistance Switch.—G. This closes or opens the lamp circuit throughout the train, and is provided with a second contact-piece which at the same time short-circuits or opens a small resistance permanently fixed in the dynamo field circuit, as when the full output is required from the machine, a stronger exciting current is necessary than when the cells only are being charged. In addition to these instruments there are two others fixed near the dynamo—viz.:

Field-Closing Relay.—H. The solenoid of this is connected direct to the cells through the switch, F, and the centrifugal contacts, K K. When F is closed, and the speed of the dynamo is high enough to close the circuit at K K, the magnet is energised, the armature is attracted and carries with it a contact-maker that connects the dynamo field circuit with the cells, the dynamo then becomes excited and starts generating current, provided the speed is sufficiently high to allow the centrifugal governor to close the contacts shown at K K on the dynamo frame.

Automatic Coupler.—J is of the ordinary pattern and wound with two circuits, having its high-resistance coil as a shunt to the dynamo terminals. The duty of this apparatus is to connect the dynamo to the cells as soon as the E.M.F. of the former is high enough to overcome the back E.M.F. of the cells, and also to disconnect it again when the E.M.F. falls too low.

Action of the Apparatus.—For the purpose of describing this fully we will suppose the train leaving the terminus at 5 p.m. The lights will probably be required while the train is standing at the platform to enable passengers to find their seats. The main switch, G, is turned on and the lamps are lighted from the cells throughout the train provided the sub-switches are closed. When the train leaves the station the light is no longer required, and the guard turns off the switch G. It is now desired to charge the cells. All the guard has to do is to close the switch F, and the governor completes the circuit through the relay, H; when the right speed—about 10 miles an hour—is attained, the relay closes the dynamo field circuit by connecting it direct to the cells, and the correct polarity is thereby assured. Meanwhile, on the dynamo starting, the brushes assumed their proper position, and in doing so shifted the reversing switch so that the field connections would be correct for the direction of rotation. When the E.M.F. of the dynamo is high enough, the coupler, J, closes and connects the cells, and charging proceeds. The field circuit current is, of course, supplied by the dynamo itself directly it commences to generate current. If the speed slackens the E.M.F. falls off, and the coupler, J, opens and disconnects the cells; should it continue falling, the governor breaks the relay, H, circuit, which in turn opens the field circuit, and the dynamo no longer generates current. At 6 p.m. the lights are again required, so the guard turns on the main switch, G, and the lamps are now supplied direct from the dynamo, the surplus current generated passing into the cells. As the switch is closed the field resistance is short-circuited, and the dynamo is enabled to generate all the current required from it. Whenever a stoppage occurs the lighting is continued from the cells without any interference of the guard, and the lamps remaining at the same degree of brightness owing to the resistance being taken automatically out of the circuit by the relay, C, short-circuiting C_1 C_2. The following figures speak for themselves on the regulating properties of the apparatus:

Speed of dynamo.	Volts at terminals of dynamo.	Amperes in lamps	Total amperes.
1,420	57	50	65
1,000	57	50	62
875	57	50	59
620	56	49	56

520 (corresponding to a speed of 10 miles an hour) dynamo automatically cut out.

Fitting and Wiring of Carriages.—There are six compartments in each coach, and each compartment has two 8-c.p. lamps, and three in the brake van make a total of 75 lamps. All the lamps are fitted in the roof with a reflector behind them, and are covered with a clear glass globe, held in place by a hinged brass ring, which is kept locked, and the lamp is therefore free from interference from unauthorised persons. The wiring is carried out on the ordinary parallel system, the lamps in each coach being arranged on two branch circuits, separately fused, so that in the event of a short-circuit and a fuse breaking only one lamp in each compartment would be extinguished. The connections are shown in the diagram, Fig. 4. P P is the main cable connected to the positive pole of the dynamo and cells through the carriage coupler. N N is the corresponding negative cable. Both of these are of sufficient size to carry current for the total number of lamps in the train, and they are placed on opposite sides of the coaches. (*p p*) is a smaller wire connected, through a switch and fuse (*s*) at the junction-box in the end of the coach, with P P, and crosses to the other side of the coach, and runs parallel with and under the same moulding as N N, all the lamps on that side of the coach being connected across those two wires N N and (*p p*). (*n n*) is a similar wire to (*p p*), and connected in the same manner to N N, and runs along the coach parallel with P P, and serves as the return for the lamps on that side of the coach. The main cables are brought through the ends of the coaches to terminal blocks enclosed in a wooden box fitted on the outside of the coach. This box also contains the switch (*s*), and from its under side depend the flexible wires for the coupling.

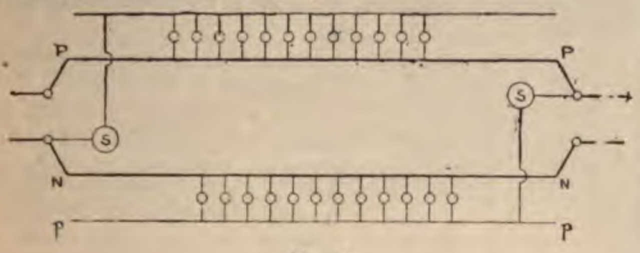

FIG. 4.

Couplings.—The requirements of a good coupling are—that it shall be capable of being easily and quickly made and broken, and, while making good electrical contact, it must be capable of breaking, with perfect ease in the event of a coach parting from the remainder of the train, and must be practically watertight. The coupling in use answers all these requirements. It consists of a brass case made in two exactly similar halves, which fit tightly into one another. The flexible wires are brought through the closed ends of the case, and connected to brass plates turned over at the end to form a spring; the plates are fixed on to a piece of hardwood screwed into the case. On pressing the two cases together the corresponding brass plates come in contact, and the connection is completed, the spring given to the plates being sufficient to hold the cases together. To break the coupling it is only necessary to pull the two cases apart.

PRACTICAL ELECTRICAL PROBLEMS AT CHICAGO.*

BY PROF. SILVANUS P. THOMPSON, D.S.C., F.R.S.

(Concluded from page 459.)

Another battle of opinions that will doubtless break out will be the old controversy as to the relative merits of alternating and direct currents. The advocates of accumulators will come armed with the latest statistics to support the latter view, whilst the advocates of alternate currents will be challenged to produce practical motors that can be put upon their circuits. The great success of accumulator stations in England will doubtless whet the curiosity of our brethren, and inspire them to point us to some still greater success of some other system on their side. It is very singular to remember in this connection that, at the Philadelphia Exhibition in 1884, there was not a single alternate-current dynamo shown—there was not, indeed, a single one in existence in the States; all machines at that date being for direct currents. Contrasting that epoch with the present, the growth of alternate-current systems to their present development seems truly remarkable. For now we have not only to discuss the general merits of alternate-current as against those of direct-current systems, but the relative merits of high-frequency as against those of low-frequency alternations; the merits of high-voltage as against those of low-voltage systems; and the merits of three-phase and four-phase alternate-current systems, as against the simple ordinary two-phase alternate-current system. Possibly many of us are becoming tired of the eternal drehstrom question. The three-phase, high voltage, long-distance transmission from Lauffen to Frankfort, 18 months ago was a magnificent *tour de force.* It showed what could be done. The generators of that splendid experiment are still running to illuminate the town of Heilbronn. But it must be confessed that even here the three-phase system has remarkably little to show of advantage over the universal two-phase system. The complications it introduces by its substitution of three wires for two, are not compensated for by any great gain. The supposed advantage that it permits the use of self-starting non-synchronous motors is, apparently, illusory; for it is clear that if the problem of giving us a satisfactory alternate-current motor, suitable for use on an ordinary two-phase circuit, has not been solved by Messrs. Hutin and Leblanc, it will be solved by Messrs. Stanley and Kelly, or by the engineers of the Oerlikon Fabrik, or by Messrs Brown, Boverie, and Co., or, perhaps, by all of these able engineers, in as many different ways. As for any supposed superiority in other respects of a three-phase or a four-phase motor over a two-phase one, it is merely a question of plant efficiency, and of comparative unimportance.

Much more attention will probably be given to the battle of the frequencies. Very low-frequency currents will apparently serve certain purposes that will make them of special use. Many years ago, M. Abdank proposed to use them for telephone signalling, and to replace telephone batteries. On the larger scale, though excellent for operating motors, they are distinctly bad for arc lighting. In the processes of simplification in central-station work, we want to be able to run the arc and incandescent circuits off the same simple pair of omnibus bars. If this ideal is ever to be obtained—and Mr. Ferranti tells us it is within our grasp—we shall have to keep up the frequency of our alternations, not lower it. In the other extreme direction we have had a most enticing field opened out by the researches of Mr. Tesla and of Prof. Elihu Thomson, upon very high frequencies. The strange properties of high-frequency discharges when supplied at very high voltages, raises a new problem. We want, as a new invention, a frequency-raiser, an organ which shall transform the frequency even as the induction coil transforms the voltage. The frequency transformers hitherto used—namely, the Leyden jar and Hertz oscillator—are not practical for electric lighting purposes. The phosphorescent glow of the novel high-frequency, high-voltage, high-vacuum lamps that Mr. Tesla promises us costs as yet much more, for equal quantities of light, than any other form of electric illumination. Who will make the new departure that will bring such lamps within practical range?

We shall discuss high voltage, too, from another point—namely, that of the utilisation of Niagara and other natural sources of power, by permitting of the economic transmission of power to long distances. Ever since 1879 this dazzling possibility has been before us. We may yet see Lord Kelvin's 80,000-volt transmission an accomplished fact. The three suggestions made in that year to attain an efficient high voltage have all been tried. Profs. Ayrton and Perry's was to run the dynamo and motor both at a higher speed. Profs. Thomson and Houston's was to put several dynamos and several motors in series. M. Achard's was to work with more powerful magnets in the machines. All three suggestions have their good points. They have been tried at Munich, at Creil, at the Gare du Nord in Paris, and notably at Frankfort; but they have also been put into practical use, by the aid of transformers, in scores of other places, and are at work to-day. What shall the next step be? Perhaps at Chicago we may hear from Prof. Forbes exactly what is to be done at Niagara.

Closely connected with power transmission comes the problem of the electric railway, and the question of rapid transit by electrical means. Several thousands of electrically-worked tramway lines throughout the length and breadth of America attest the extraordinary progress of recent years. And if America cannot yet show one single electric railway on the scale of our City and South London line, it is probably because she has some great surprise in this direction in store for us, and will throw our present advantage in this point into insignificance. Subsoil roads are certainly going to revolutionise the cross-traffic of all great cities. But will not America show us something much bigger and more daring than our little six-mile pair of tunnels from King William-street to Stockwell?

The applications of electricity to mining must also come in for discussion, and many other engineering applications. Many engineers are now alive to the possibilities of electromagnetic mechanism. Friction clutches are being superseded by magnetic ones, and a recent suggestion of Mr. Edison is to increase the grip between belts and pulleys by the introduction of magnetic adherence between them.

Turning from the problems of heavy engineering to those of lighter electrical appliances, there are still matters innumerable awaiting discussion. We shall have the new "telautograph" of Prof. Elisha Gray to admire. We shall canvass the probabilities of its adoption and development as keenly as we did nearly 20 years back those of the telephone. It is a matter of congratulation that Dr. Gray, who at that time was somewhat cruelly pushed aside, in the pressure of events, from receiving his due share of recognition for the part he played in the early stages of telephonic progress, should now have made such an apparent success with the later creation of his inventive brain. The cruder tentative autographic telegraphs of the earlier workers cannot be put into the same line as the wonderfully perfect instrument which will assuredly be one of the features of the Chicago show. But there are other battles to fight in the telegraphic field. Our system of rapid automatic transmission, originated by Wheatstone, and perfected steadily and surely under the hands of the British Postal Telegraph Department, has not yet superseded all the older and slower forms of telegraphic instruments, even on those lines where Press work and heavy commercial work demands the most perfect and efficient instruments. It is strange that in the United States, where such commercial considerations are deemed quite as important as they are with us, the adoption of the rapid automatic system should be so slow. American telegraphers were not one whit less quick than we to perceive the advantages of duplex and of quadruplex working. In respect to quadruplex, though Europeans worked out both duplex and diplex, and had shown that, by combining them, a quadruplex transmission was possible, it was yet left to American electricians to put into service and to devise the practical combinations for every-day use.

The problem of the fuller utilisation of telegraph and telephone lines takes fresh importance every year, as traffic thickens, and the possibility narrows, of adding new lines beside those already darkening the air. Rapid automatic transmission is, for many purposes, a far more efficient service than the quadruplex. Then there is the question of harmonic duplex and multiplex telegraphs. At Chicago we shall see the phonopore doing service not only as a harmonic duplex, but also for providing a telephonic service upon the railway signal lines to keep up communication from cabin to cabin of the block system. This ingenious adaptation of devices has received, since its inception by Mr. Langdon-Davies, numerous improvements in detail of late from that ever active veteran telegraph engineer, Mr. Spagnoletti, and I am told that the instruments at Chicago will also embody the results of some suggestions made by the officials of the British Post Office when the instruments were tried there.

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* Paper read at the Society of Arts on May 3.

The rapidity of signalling through cables is a matter which our president of to-night—the official representative of Great Britain in matters electrical—has given much attention. He has shown us what careful design may accomplish in the matter of the telephone cables from England to France and from England to Ireland. The next step will be to show that it is possible to talk by telephone through the 220 miles of sea that separate England from Holland. There is not the least reason why that should not be done within the next 12 months. This is a matter to which recently I, too, have been giving some attention, and it is perfectly clear to me that, by taking into account the action of electromagnetic induction in diminishing the retarding effects of capacity, and utilising that property rightly, it is only a question of time and money to effect telephonic communication through even an Atlantic cable. It is possible that at the present moment no two telegraph engineers would agree on the right way to carry out the thing. Few, if any, would deny the abstract possibility. It affords a splendid field for discussion. Above everything we want a few suitable hard facts of experiment as data to base argument and calculation upon. Long-distance telephony is no mere dream. Nor is heckto-plex telegraphy. And telegraphy without wires is already, in isolated cases, an accomplished fact. Seeing by electricity, in spite of the telephoneroscope which graced the jubilee soirée of the Postal Telegraph Office, must be left to the twentieth century. We have problems enough to discuss at Chicago without entering upon that enticing phantom.

Those of us who may enjoy the benefits of a trip to Chicago will, it is clear, have to encounter a perfect tornado of electrical ideas. We go to mingle with our brethren of the electrical craft in friendly converse, as admirers, let us trust, rather than as critics. On whatever points of practice we differ we may be sure the advantage is not all on our side, and shall be ready to give a hearty appreciation to, and to enter into an intelligent understanding of the causes that make those differences of practice, even when they are differences that tell against ourselves. There are moments when one would wish to dispossess oneself of the critical faculty and instead acquire an unlimited capacity for admiration. The exhibition itself will give us much matter for genuine admiration: the congress will equally furnish us with food for thought. The country which produced a Franklin, a Henry, and a Morse, is happily still rich in citizens of distinction in electrical science; for it can boast a galaxy of names as eminent as those that can be produced by any country in Europe, as eminent not in abstract science only, but also in the work of pioneer investigation, and in the genius for utilising the forces of nature for practical ends.

EARTH-CURRENTS IN INDIA.*

BY E. O. WALKER, C.I.E., MEMBER.

Papers on this subject were published in the *Journal* for the years 1883, 1884, 1888, and 1891. More recent observations, in connection with those previously taken, have led to an identity being revealed between the variations of these currents and those of atmospheric pressure. It is thought to be of interest, as the comparison is novel, to give a brief account of the facts which seem to establish this identity. In doing so references must necessarily be made to the former papers. In the study of this subject much assistance has been afforded by the records kindly placed at my disposal by Mr. C. Chambers, F.R.S., superintendent, Colaba Observatory; Mr. Michie Smith, F.R.S., Government astronomer, Madras; and Mr. E. Kitto, F.R.Met.S., superintendent, Falmouth Observatory; and by information furnished by Mr. W. Ellis, F.R.A.S., Greenwich Observatory; reference has also been made to the Bombay meteorological observations of 1845, and to the *Encyclopædia Britannica* (ninth edition, vol. xvi.—"Meteorology").

The observations in India were not as a rule taken with a sensitive galvanometer, for the currents were of sufficient magnitude in the localities in which observed not to require it. The use of a sensitive galvanometer involves complications from weak electro-chemical and thermal currents produced at junctions, and the magnetic system is subject to displacement for terrestrial magnetism, the effects of which are difficult to screen. In all delicately-suspended magnets with long indicators, or with reflectors and distant scales, these effects are considerable.

It is necessary to remark that the long periods of settled weather in India are favourable to the regular recurrence of the same variations in meteorological phenomena from day to day during those periods, and this has been found to be the case with the earth-currents. For fully 30deg. north and south of the equator the lines of maxima and minima run north and south, but in higher latitudes these directions are changed. Again, the amplitude of the oscillations of atmospheric pressure is greater in equatorial than in higher regions, and, so far as can be ascertained, the earth-currents have higher E.M.F.'s in the former than in the latter. On the whole, therefore, India offers a better field for observation than the British Isles, where the weather is subject to such large and frequent disturbances from often unknown and unforeseen causes.

In my papers of 1884 and 1888, reference has been made to difference in elevation between two places being favourable to the production of an earth-current, and to the probability that at any time difference in atmospheric density is also effectual in this way. Condensation and dispersion of aqueous vapour at high elevations have by other observers been shown to affect the direction of the current. On the coast of India the disturbances to telephonic communication, when earth has been used, have been very great on long circuits during that part of the day when solar heat was most active, and when the sea-breeze prevailed, the cause apparently being that electrically-charged films and particles of vapour were driven across the wires and discharged into them. The effect was to produce a hissing or grating noise on the telephone, which often drowned the voice of the operator. It is thought, then, that these considerations, coupled with the results of fresh observations which follow, may lend colour to the supposition that the movements of aqueous vapour, as evidenced by the daily barometric oscillations, are active in the production of earth-currents.

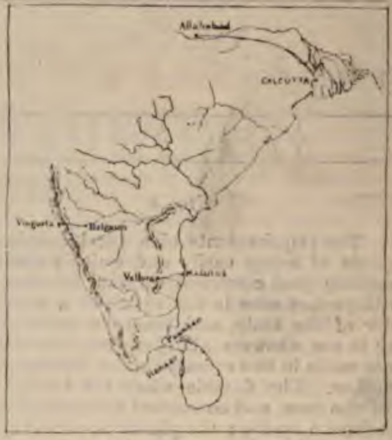

Fig. 1.

Observations of earth-currents have been taken on some days in March and April, 1891, between Belgaum and Vingorla; in February and July, 1892, between Madras and Vellore; in June and July between Paumben and Manaar; those of September and October, 1887, between Calcutta and Allahabad, also illustrate the same features of the daily recurrent phenomena. It is found that almost always the current flows in the morning from the inland places of observation to those on the sea-coast. A sketch map is appended to show the geographical positions of the places indicated. In the afternoon the direction of the current is reversed. On the sections of lines from Belgaum to Vingorla and Madras to Vellore, currents of high E.M.F. are observed from a half to five volts; they are remarkably steady, and cannot be produced by electro-chemical or thermal influences at the earth-plates. Some observations kindly taken on one of the Madras-Penang cables in July, 1892, by Mr. Wolfe, acting-superintendent at Madras of the Eastern Extension Telegraph Company also showed that E.M.F.'s of from 0·1 to 14·4 volts were operating from 6.37 a.m. to 9 11 a.m. (between which hours observations only were made), and go to strengthen the conclusion that comparatively high forces do prevail about the time of the morning maximum of atmospheric pressure. The curve which shows the changes from early morning to evening was given in Plate I. of my paper of September, 1884, and this is reproduced here (Diagram II.). These diurnal phenomena are occasionally reversed in times of cyclonic storms. The cables from Madras to Penang give evidence of similar effects.

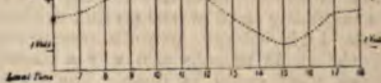

Fig. 2.

The observations taken at Paumben on the line to Manaar are very instructive: they comprise seven days; the current was very weak, and exhibited no regularity in ebb and flow. The line is about 50 miles in length with a cable in circuit and runs east and west. The difference between the phenomena exhibited here and those of Vellore and Belgaum I attribute to the fact that there can be but little difference in the meteorological conditions of Paumben and Manaar, and barometrical oscillations of the same sign and amplitude occur synchronously at the two places. It is to be regretted that this supposition cannot be confirmed by records. It should not be omitted, however, to note that Paumben is only 13 miles south of the magnetic equator, and it is possible that magnetic forces there are variable to a greater extent than at the other places noted above. The photographic records of the earth-current at Greenwich Observatory in the line running east and west, prior to the disturbance which is caused by the City and South London Railway currents, show a rise and fall in the earth-current similar to that exhibited in Diagram II. herewith, although in a circuit only three miles in length the E.M.F. is very small.

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* *Paper read before the Institution* of Electrical Engineers.

of the disturbing field. Analogous effects had also been observed by Prof. Schuster, and described in his Bakerian lecture. **Mr. E. W. Smith** regarded the stresses set up in the medium as cumulative, a very slight cause acting on a substance already strained nearly to breaking point being sufficient to cause breakdown. **Mr. Blakesley** enquired if the effects were the same if the induction coil used in one of the experiments was replaced by an electric machine, and whether the direction of the field so produced influenced the result. **Mr. W. R. Pidgeon** said closed circuits were necessary, and he had found it very difficult to produce discharge in tubes unless the ends of the primary wire were brought together. In his reply, **Mr. Rimington** said each turn of the luminous spiral formed a complete circuit of itself. The phenomena observed by Mr. Campbell Swinton was quite different to those he had shown, and due to different causes. Mr. Swinton's spirals were reversed, and were due to phosphorescence of the glass

COMPANIES' MEETINGS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The ordinary general meeting of the Brazilian Submarine Telegraph Company, Limited, was held last week at the City Terminus Hotel, the Hon. W. St. John Brodrick, M.P., presiding.

After referring to the absence of the chairman of the Company. Sir James Anderson, owing to severe illness, the **Chairman** moved the adoption of the report. He stated that the revenue of the Company for the half-year ended December 31 last had exceeded that of the preceding six months by rather over £2,000. The increase, however, was rather apparent than real, because a certain sum came into the accounts of the past half-year which had been held in suspense in the preceding half-year, and this would have just altered the balance. Comparing their revenue for the December half of 1892 with that for the corresponding period of 1891 there was a decrease of £13,000, but, on the other hand, there had been a diminution in the expenditure of about £5,000, although they had had to meet some unusual calls in connection with their staff quarters at St. Vincent, in consequence of the large amount of business and the establishment of a day and night service there. In addition to this they had thought it wise to erect tanks and tank-sheds and to provide machinery at St. Vincent for keeping spare cable there; and the shareholders would be able to appreciate the foresight which had dictated this operation when they considered the instance of the repair which had just been executed to the cable which had been broken near Pernambuco. They took the nearest and most easily available telegraph ship to repair it, the vessel being at the time on the West Coast of Africa. She called at St. Vincent, and, having taken in the necessary cable, proceeded direct to the scene of the break, which was repaired on the 28th ult., and she was able to return without even touching at South America. A company had been established connecting Senegal with South America which might be considered to be in opposition to their Company. The South American Company opened on October 5 last, but on December 27 a break occurred in their cables, which were totally interrupted until February 9. Notice was recently given by that company of a decrease of rates, to take effect from the 1st ult. After consulting the Western and Brazilian Company the Directors decided to adopt similar rates, and as the object of the South American Company was to take away this Company's traffic, the Board would, if necessary, continue to reduce rates to the level notified by the opposition. The experience gained from the working of the South American Company did not, however, make them greatly fear the loss that might be incurred by the competition. They proposed to ask the shareholders' authority to establish a fund for the pension and superannuation of their employés. By the adoption of the proposal they would also have something of a hold on valuable men, so that when they had given the Company a certain period of service they might not be induced to transfer their abilities elsewhere. The shareholders voted on May 20, 1881, a sum not to exceed £800 a year towards an insurance fund, and this would in the future still suffice for the payment towards the superannuation of the older members of the staff. As regarded the younger members they proposed, on the part of the Company, to make a contribution of 2½ per cent. to their contribution, and at the present rate of the salaries this would cost the Company about £500 a year, which he did not think would be regarded as an undue amount.

Sir H. D. Gooch seconded the resolution, which was carried.

On the motion of the **Chairman**, seconded by **Mr. John Newton**, a resolution was afterwards passed approving the report of Messrs. Neison and Schooling, of the Institute of Actuaries, relative to the establishment of staff pension and superannuation funds.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY, LIMITED.

The adjourned extraordinary general meeting of this Company was held on Monday at Winchester House to consider a resolution for winding-up the Company with a view to its reconstruction. Major C. Jones presided.

The meeting at the outset was adjourned until after the business of the ordinary general meeting had been disposed of.

Mr. Wood, the chairman of the committee, proposed a resolution *approving* of the sale of the Company's factory and works in *France to M. Secretan in terms* set forth in an agreement read to the meeting. By the agreement a French *société en commandite* is to be formed with a new capital of £100,000, the new company issuing to the present Company £60,000 first mortgage debentures and 5,000 founders' shares. The new company will purchase from the Company all the French assets, with some unimportant exceptions, and will undertake to pay all the existing French liabilities, and to be responsible for all the expenses of carrying on the business as from the 20th ult. The price to be paid to the Company is as follows: (*a*) A net sum in cash of £8,600, this being the net amount of the £20,000 originally settled after deducting the agreed sum for the discharge of all French liabilities and cost of working till completion of purchase. (*b*) An amount of £60,000 in first mortgage debentures ("obligations") bearing 6 per cent. interest and a 40-year sinking fund. If paid off before maturity a bonus of £6,000 to be paid in the first year, diminishing in proportion to the years run off. (*c*) All the founders' shares, receiving £4,500 per annum after the new capital has received 10 per cent. (non-accumulative), and entitled to one-half of surplus profits after certain specified provisions are made for reserves, etc. Two out of the five members of the committee of supervision are to be nominated in the interests of the English company; £10,000 of shares now held in France will be cancelled or surrendered by the arrangement. Mr. J. H. Duncan (the receiver and manager), in his letter of the 29th ult., in forwarding the above-mentioned summary of the proposed agreement with M. Secretan and his group of French capitalists, remarked that the chief alteration from the original scheme was that the founders' shares were no longer expressed in a capital sum of £60,000. Under French law it was impossible to give a capital value to founders' shares, but their revenue rights had been kept exactly as before, and their participation in the ultimate surplus of assets was also provided for. Up to the 19th inst. it was to be open to any of the shareholders to join in finding the new capital which was being subscribed in France with preferential rights.

After some discussion the resolution approving the proposed sale was passed, and a resolution was also carried adopting the Directors' report.

The extraordinary general meeting was subsequently proceeded with, and resolutions were passed for winding up the Company and appointing Mr. F. W. Pixley liquidator.

BUSINESS NOTES.

Wakefield.—The Wakefield City Council have decided to apply for a provisional order.

Hanley.—The Hanley Town Council advertise for an electrical engineer at a salary of £200 a year.

Reading.—The Reading Town Council have authorised the town clerk to proceed with the provisional order.

Electrical Trades Union.—A delegate meeting of the Electrical Trades Union is to be held at Newcastle on Whit Monday.

St. James's and Pall Mall.—The St. James's and Pall Mall Electric Company have removed their offices from Mason's-yard to the Company's new central station in Carnaby-street, Golden-square, W.

Dorset Asylum.—It has been decided by the Dorset City Council to light the new asylum by electricity. The chairman of the Council is Lord Portman. The Asylum Committee have the matter in hand.

Dorsetshire.—Arrangements, says a local paper, are being made not only for lighting the town of Dorchester, but for storing electricity for the supply of the whole county. Notice has been given to the Board of Trade.

Portsmouth.—At the Portsmouth Town Council meeting last week, the progress of the electric lighting arrangements was shown by the fact that £840 was voted to the contractors, on the certificate of Messrs. Waller and Manville.

City and South London Railway Company.—The receipts for the week ending May 7 were £793, against £802 for the same period last year, or a decrease of £9. The total receipts for 1893 show an increase of £1,255 over those for the corresponding period of 1892.

Bridlington.—On the recommendation of the Parade Committee, it was resolved by the Bridlington Local Board last week to purchase a Crossley Otto gas-engine, at a cost of £340, for supplying the necessary motive power for lighting the Prince's Palace by electricity.

Sale.—On Tuesday, 30th May, and two following days, at South Woodside-road, Kelvinbridge, Glasgow, a sale by auction will be held of the whole plant, material, tools, and stock belonging to the Woodside Electric Company, by Messrs. Duncan Keith and M'Cloy, West Regent-street, Glasgow. The sale takes place on account of expiry of lease.

Dorchester.—At a meeting of the Dorchester Town Council last week it was decided, after a stiff fight, that authority be given to the General Purposes Committee to obtain the advice of Messrs. Newton, electrical engineers, of Taunton, as to the necessary alterations and cost requisite for providing the town with a service of electric lighting.

Barnet.—A letter from the Board of Trade to the Barnet Local Board, read at last week's meeting, stated that a Bill was introduced into the House of Commons on April 25 to confirm, amongst others, the provisional order with regard to electric lighting. Mr. Morse said that in the absence of opposition the order went through the House as a Government Bill.

City Transformer Stations.—At the meeting of the City Commissioners of Sewers, on Tuesday, an application from the City of London Electric Lighting Company to grant sites for six more transformer stations to enable them to complete the lighting of the City was agreed to.

Aberdeen Stores.—A committee of the directors of the Northern Co-operative Company of Aberdeen have met Prof. Kennedy to discuss the lighting their large stores in Gallowgate. Prof. Kennedy is to furnish a report, with the view of showing the cost of fitting up and working an electric installation, as compared with the cost of a scheme of lighting by gas.

Imperial Institute—The electrical apparatus whereby electrical communication was made with the belfry to start the peal of bells was designed and erected by Messrs. Julius Sax and Co., Limited, under the personal supervision of Alfred Slatter, their manager, as well as the electric lighting of the Queen's lift, and complete telephonic and bell communication throughout the building.

Blackburn.—The Blackburn Town Council have authorised the seal to be affixed to an agreement with Mr. Thomas to serve as electrical engineer during the installation of the electric light in the centre of the town. Alderman W. Thompson explained, in answer to Councillor Cooper, that the appointment was made at a specific sum for a specific work, and was not intended to be a permanent one.

Islington—The Board of Trade has intimated to the London County Council that it proposes to omit paragraphs from the Islington provisional order containing restrictions with reference to the purchase of houses occupied by the labouring class, and to substitute clauses which in effect follow section 49 of the Thames Tunnel (Blackwall) Act, 1887. The County Council see no objection to this course.

Extension at Morecambe.—In consequence of the growth of their business, the Morecambe Electric Lighting Company have resolved to increase their generating plant so as to supply an extra 1,500 16-c.p lamps. Additions are being made to the Dowson gas-making apparatus, and a large dynamo of the Preece type is being put in. The dynamo will be driven by a gas-engine, built specially for the work by Messrs. Crossley Bros.

Old Paris, Earl's Court.—We understand that Messrs. Vaughan and Brown, of 15, 16, and 17, Kirby-street, Hatton-garden, have supplied all the electric light for the exhibition of Old Paris at Earl's Court. A large number of arc lamps on columns and brackets illuminate the grounds and dairy; also old lamps direct from Paris light the front of the shops. The inside of the churches, restaurant, hotels, houses, and shops are all illuminated with many thousands of incandescent lamps, giving a very pretty effect.

Buckingham.—At the Buckingham Town Council meeting the Lighting Committee recommended that the tender of Messrs. Parr and Gillies, proprietors of the electric light company, be accepted for illuminating the dial of the Town Hall clock for the year for £5. 6s. A tender, however, was now received from the gas company, offering to light the clock for £4. 10s. It was said that the cost heretofore had been about £10 and £11 per year for the gas. It was decided to refer the two tenders back to the committee.

Free Telephonic Communication.—Alderman Snape called the attention of the Lancashire County Council to the fact that whereas the telephone companies in the county paid only £112 for the privilege of erecting poles along the roads, this Council paid £2,500 a year to the companies for telephonic communication between the various county offices and institutions. He suggested that a proper and more equitable arrangement would be to have free telephonic communication for the privileges afforded. The proposal, however, was received with laughter.

Dewsbury.—The Lighting Committee of the Dewsbury Corporation last week had before them the question of electric lighting. The matter has now been put into such a form that after being dealt with in consultation with their consulting electrical engineer it will be laid before the monthly meeting of the Town Council this week. A number of tenders for buildings, engines, boilers, dynamos, etc., were provisionally accepted, the whole amounting to a little over £12,500. The scheme does not comprise street-lighting by arc lamps.

Brighton Switchboards.—Tenders are required for the supply and erection at the electricity works, North-road, Brighton, of a central-station switchboard and apparatus, for the Corporation. Specifications can be obtained on application at the office of the Town Clerk, Town Hall, Brighton. Tenders must be left at the office of Mr. F. J. Tillstone, town clerk, Town Hall, Brighton, before 10 a.m. on 15th inst. A fee of one guinea will be charged for specification, which will be refunded on the return of the specification, accompanied by a bona fide tender, on or before above date.

Aladdin Primary Electric Battery Company, Limited.—This Company has been registered by Stokes, Saunders, and Stokes, 21, Great St Helens, E.C., with a capital of £6,000 in £10 shares. Object: to acquire certain patents relating to improvements in electric primary batteries and miners' safety lamps, and to develop and turn to account the same. The first directors—to be not less than three nor more than five—are R. T. Coad, H. Bonner, P. M. Mountain, and A. Saunders. Qualifications, £200. Remuneration, one-tenth of the profits of the Company—not to exceed £200 per annum.

Birkenhead.—The Finance Committee of the Birkenhead Town Council have resolved that Messrs. Deakin, Gostenhofer, Willmer, Bloor, John Laird, J. Edwards, and the Mayor be appointed a sub-committee to consider and report to the committee as to the steps to be taken in regard to the carrying out of the provisions of the Birkenhead Electric Lighting Provisional Order, 1890, and that a sub-committee be authorised to obtain such professional and other advice or assistance, and to take such steps and incur such expense as might be necessary or desirable.

Redditch.—At a meeting of the Redditch Local Board last week, Mr. T. Evans reported that the committee appointed to consider the matter were of opinion that the Board should allow a sum not exceeding £50 for engaging an electrical engineer to prepare plans and specifications for laying down a plant sufficient for supplying the town with electric light, and to obtain estimates of cost of work. The Board would then be in a position to judge of the advisability of entering upon the scheme or not. The matter was fully discussed, and it was decided to engage an electrical engineer, as suggested.

Ponsonby Hall.—The ancient seat of the Stanleys, Ponsonby Hall, now in the occupation of Mr. W. B. Turner, has been fitted up with the electric light. The electricity is generated by a turbine driven by water obtained from the Calder, on the bank of which a dynamo-house has been built. The house contains one dynamo which drives the electricity up to the hall, where it is stored in 53 accumulators, placed in a room specially adapted for the purpose. From this room the electric light is carried all over the house, and distributed in single lights or chandeliers of three or four lights each.

Partnership Dissolved.—The partnership lately carried on by Mr. Vincent S. Allpress and Mr. Thomas Oswald Belshaw, under the name of "Allpress and Belshaw," has been dissolved as from the 9th inst., and in future Mr. Allpress will carry on business as as electrical engineer and contractor under the name or style of "Allpress and Co.," retaining the old offices, 55, Victoria-street, Westminster, S.W. Mr. Allpress has had large and varied experience in connection with the installation of electric lighting in private and public buildings, the installation at the Imperial Institute being one of the best examples done by the late firm.

South Shields.—The Corporation of South Shields obtained their provisional order two years ago. They have now obtained a report from Mr. E. J. Jennings, who considers plant for 6,000 lights would be sufficient for the compulsory area, including the Corporation offices. Provision for extension to the amount of another 2,000 is thought necessary—making a total cost of £14,000. Mr. Jennings thinks if the price is fixed at 5¾d. per unit this will pay. On the 6,000 lights the estimated profit is £1,094. The Electric Lighting Committee have visited Newcastle to inspect the system in use there. An extension of time will be required to keep the provisional order in force.

St. Luke's.—A special meeting of the St. Luke's Vestry will be held to consider the recommendations of the Works Committee asking the Vestry to accept the tender of Messrs. Goddard, Massey, and Warner, of Traffic-street, Nottingham, for the construction and provision of a Warner's "Perfectus" destructor, slop-tanks, high-level platform, roof, inclined road, and electric light, in accordance with the specification, for £5,896, and the further tender of this firm for the high-level platform, girders, columns, and brick arches, inclined roadway, concrete foundations, stone bases, slating to roof, and woodwork in slop-tanks, electric light plant, and engine-house buildings, at a sum of £3,459.

Ealing.—The Ealing Local Board invite tenders for Lancashire boilers, machinery, and accessories. Plans may be seen for the boilers after the 6th inst., and for the machinery after the 15th inst., on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to Mr. C. Jones, C.E., the surveyor to the Local Board, at their offices, Ealing, from either of whom may be obtained a printed copy of the specification and form of tender, on deposit of £2. 2s., to be returned on receipt of a *bonâ fide* tender. Tenders, addressed to the Chairman of the Ealing Local Board, at the offices of the Local Board, Ealing, must be delivered for the boilers by the 17th, and for machinery by 30th inst.

Bournemouth.—The Bournemouth Roads Committee's report stated that an application, dated April 21, had been received from the electric light company for permission to put down a main along Surrey-road, St Stephen's-road, and Yelverton-road to the sub-station at the Quadrant, and stating that they were willing to give an undertaking that the main should not be tapped for the purpose of supplying current to houses, it being intended only to convey current direct from the works to the sub-station. The Roads Committee recommended that consent be given, subject to an understanding that the main should not be used to supply current along the route, and subject to all joints being tested to the satisfaction of the Council. The resolution was adopted.

Electric Traction.—The following notice of motion has been given in the House of Commons by the Chairman of Ways and Means for Friday, May 12: "The Chairman of Ways and Means—Electric Powers (Protection Clauses)—That a joint committee of Lords and Commons be appointed to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return circuits or by any provisions as to leakage, induction, or similar matters, and if so, in what cases and under what conditions. And if the joint committee are of opinion that any such prohibition, restriction, or provision should be enforced, to settle the necessary clauses. That a message be sent to the Lords to communicate this resolution and desire their concurrence."

West India and Panama.—The report of the West India and Panama Telegraph Company for the half-year ended December 31 last states that the amount to credit of revenue is £38,358, against £36,141 for the corresponding half-year of 1891, and the expenses have been £25,155, against £25,296 for the same period of 1891, leaving a balance of £13,203, which, with £3,704 brought from last account, makes a total of £16.907. Of this sum the Directors have placed £1,500 to reserve, leaving an available balance of £15,407, with which it is proposed to deal as follows: First preference shares dividend, six months to December 31, 6s. per share, £10,368; second preference shares dividend, six months to December 31, 6s. per share, £1,400; ordinary shares, 6d. per share, free of income tax, £2,208; and balance to current half-year's account, £1,430.

Burnopfield Co-operative Society.—Messrs. Ernest Scott and Mountain, electrical and general engineers, Newcastle-on-Tyne, have secured the contract for the electric lighting of the Burnopfield Co-operative Society's premises at Burnopfield. This installation will be driven from a 7-h.p. nominal Priestman oil-engine, which was fixed a short time since with a view of being utilised for working the electric light as well as driving the hoist. The installation will consist of one of Messrs. Scott and Mountain's improved Tyne dynamos, capable of running 100 16-c.p. incandescent lamps with accumulators, and about 100 16-c.p. lamps fixed throughout the premises. Messrs. Scott and Mountain have already done a considerable amount of work for the various co-operative societies, and have recently completed a large installation for the Co-operative Wholesale Society at Newcastle-on-Tyne, and also lighted the Dunstan flour mill, and the co-operative stores in Newgate-street, Newcastle-on-Tyne.

Bury.—In the minutes of the Bury Electric Lighting Committee presented to the Town Council meeting last week was a very long report of visits paid by some of the members to Oxford, London, Eastbourne, Woolwich, and Cambridge to obtain reliable information as to the supply of electricity from central stations, as the Corporation are bound to do something at an early date to carry out the electric lighting order they have obtained. It was stated that the chief difficulty which troubled the committee was whether to adopt "alternating" or "continuous" currents. They recommended that they be authorised to obtain a number of preliminary competitive tenders with full liberty to adopt and recommend such systems and types of motive power and dynamos as they may deem best suited to those conditions, and to engage a consulting engineer to advise them and superintend the works. The minutes were passed, after a little discussion, on the proposer consenting to leave out the words "and adopt" and "to superintend the works." It was explained that it was not intended that the consulting engineer should carry out the works.

Derby.—The Derby Electric Lighting Committee, in their report to the Town Council last week, intimated that the by-pass near the Corn Mills had been covered, at a cost of £58. 10s. The tender of Messrs. Siemens Bros. and Co., Limited, of London, for providing and laying of mains, ways, etc., with all accessories in connection with supplying electric light has been accepted. The engineers have informed the committee that the electric light will be ready for supply by the middle of July. The committees having charge of public buildings have been informed of this, with an intimation that steps should now be taken to wire any buildings in which the light will be required. On the proposition of the Mayor, seconded by Mr. Sutherland, the minutes were confirmed. In our report last week we referred to the statement that the Town Council propose, on the advice of Sir Frederick Bramwell, to experiment with electrical treatment of sewage. This should have been on the advice of the firm—Messrs. Bramwell and Harris, of 5, Great George-street, Westminster, who are engineers to the Corporation. In describing the central electric lighting works it should also have been stated that the supervision of the whole installation is in the hands of the same firm.

Burton.—At the quarterly meeting of the Burton Town Council last week, the Gas and Electric Light Committee recommended the acceptance of the tender of Messrs. Fowler, of Leeds (in conjunction with that of Messrs. Hammond), for the electric lighting works. Alderman Lowe, in moving the adoption of the report, said a strong feeling existed in the town that another winter should not be allowed to pass before the introduction into the borough of the electric light, and although some members might be inclined to accuse the committee of dilatoriness in the matter, he could assure the Council that they were pushing the project forward with all speed consistent with safety. While there was hardly a shadow of a doubt but that the application of the Council would be approved, they had not received any intimation from the Local Government Board, but in order to properly safeguard themselves from responsibility, they asked permission to issue the contracts with the clause inserted, "Subject to the sanction of the Local Government Board." He hoped that by Christmas Eve at any rate the electric light would be in Burton. The report was adopted.—Mr. Harold Waring has been appointed clerk of the works in connection with the electric lighting contracts to the Burton Corporation.

City Electric Lighting.—The City of London Electric Lighting Company give notice that application is being made by them to Parliament this session for a Bill to alter and amend the provisions of the City of London Electric Lighting (Brush) Order, 1890, the City of London (East District) Electric Lighting Order, 1890, and the City of London Electric Lighting (Brush) Order, 1891, with respect to the keeping of accounts and setting aside of depreciation and reserve fund, and to alter or prescribe the amounts to be debited to the annual accounts of capital employed for the purposes of these orders for depreciation and for reserve and other funds, and to provide for the investment and application of moneys so debited. The Bill will contain clauses providing that the undertakings authorised by the provisional orders mentioned hall be deemed to be one undertaking, and exempting from the operation of the Metropolitan Building Act, 1855, any building used by the company wholly for generating energy to be supplied under the provisions of the Brush Orders, 1890 and 1891, the East District Order, 1890, and the Southwark Electric Order, 1891. Printed copies of the Bill have been deposited in the Private Bill Office of the House of Commons. Mr. Sidney Morse is the solicitor for the Bill, and the parliamentary agents are Messrs. Rees and Frere.

Underground Telephone Wires in Manchester.—At the Manchester City Council, on the 3rd inst., Mr. Southern referred to a paragraph in the Paving Committee's proceedings setting forth that the town clerk was instructed to prepare a report upon the subject of underground telephone wires for the consideration of the committee; that the city surveyor should furnish such particulars, to be embodied in the report, as might be necessary; and that the advice of Dr. John Hopkinson be obtained in relation to the subject. He pointed out that the instruction was issued in relation to a letter from the National Telephone Company, dated October 20th last, and said he thought the matter should be considered by a special committee. He said that without disparaging in any way the Paving Committee. The matter of telephonic communication in Manchester should not be considered simply upon the initiative of a private company. His object was to obtain the best telephonic communication for the citizens of Manchester at the lowest cost. He moved that the proceedings of the committee be approved, with the exception of the part relating to the underground telephone wires, and that a special committee be appointed to consider the matter. Mr. Alderman Mark seconded the resolution. Mr. Southern named his committee, but upon a division his amendment was lost. Mr. Clay then moved a further amendment to the effect that the proceedings of the committee be approved with the exception of that portion relating to the National Telephone Company. Mr. Alderman Evans seconded, and the amendment was adopted.

Aberdeen Contracts.—At the Aberdeen Town Council meeting the Gas Committee reported the acceptance of offers—amounting in all to £17,977—for the buildings and plant required for the electric lighting station in Cotton-street, and recommended the borrowing of £25,000 in connection with the undertaking and the appointment of a resident electrical engineer, the terms of whose appointment the committee should be instructed to report upon. The deputy town clerk read a letter from Messrs. M'Gregor and Shand (whose offer, amounting to £92. 5s. 8d., for the slater work had been accepted) stating that, as they had seen by the newspapers that they were the lowest offerers, and as they had found that they had made a very great mistake, which would entail a great loss, they therefore refused having anything further to do with it Mr. Farquhar (the convener) said the committee proposed to give the contract to Mr. Milne, Crown-street, who was just £2. 14s. above M'Gregor and Shand. Bailie Kemp knew nothing about this case; but there was a principle involved in it. When he was shoremaster firms had done the same, and he had to put down his foot very firmly against such a course. This withdrawing from a distinct offer should not be allowed, if a firm were capable of being entrusted with the work, unless they could give satisfactory explanation to show there was foundation for the assertion that a mistake of a serious kind had been made in the calculations. It was a pity for the sake of £2. 14s. to withdraw from a contract. Mr. Farquhar said he had raised his voice again and again against this sort of thing, which was happening very frequently, and he regretted very much that this had occurred. It had been explained by the fact that the senior partner had been ill and not able to attend to business. The Lord Provost thought that where such withdrawals were not satisfactorily explained to a committee the firms should not get schedules. The matter then dropped, the offer of Mr. Milne, the next lowest offerer, being accepted. The minute otherwise was adopted.

Woodhouse and Rawson United.—The following circular has been issued by Mr. F. D. Leslie, of the firm of Messrs. Robinson and Leslie, to the holders of first mortgage debentures and debenture stock: "In March last I was appointed by the Chancery Division of the High Court of Justice, receiver and manager of this Company, on behalf of all the debenture and debenture stockholders, and since that time I have been endeavouring to arrive at the position and prospects of the undertaking and to satisfy myself as to what would be the most advantageous course to pursue in the interests of the debenture-holders and other secured creditors. I may say that I found the accounts in such a state that it was extremely difficult to arrive at either the amount due to the Company or its liabilities. I am now, I trust, succeeding in bringing the accounts into a satisfactory shape. There are so many branches and agencies spread all over the world that it is almost an impossible task in something less than two months to get at the true position of the whole undertaking. I have, however, with the sanction of the Court, despatched an agent to Africa, who will investigate the position there and look after the assets to the extent of over £20,000, which the books of the Company show are at Johannesburg and the other South African agencies. I have taken steps to preserve the assets in Sydney, and to settle the difficulties with the Barcelona and Milan agencies. I have closed down the Bristol branch and Hamburg agency, and am gradually doing likewise with the Cadby Hall works. I have reduced the expenses at head office on account of salaries, wages, and rent at the rate of over £4,000 per annum. I have obtained leave to collect the debts due to the Company on behalf of and for the benefit of all the debenture and debenture stockholders, and to deal with the outstanding calls in the same way, except as far as they are specifically pledged as security for previous advances, and I have generally, so far as I have been able, done all that I can to keep the business alive and preserve the estate for the benefit of those who are entitled to it. It is very difficult to estimate what the various classes of debenture-holders may reasonably expect from a realisation of the estate, because so much depends upon the way in which it is realised. Speaking with considerable doubt, I am inclined to think that the first mortgage debenture-holders and the secured debenture stockholders (issued in December, 1892) may expect to be paid in full; but as to the debenture stockholders (5½ per cent.), I have very little doubt that unless some reconstruction scheme is proposed and carried through they will be considerable sufferers by the unfortunate stoppage of the Company. As to the feasibilty of reconstruction and the proposals which are, I am told, about to be made, it is quite impossible for me to speak until some scheme in a concrete form is offered for the approval of the various classes of creditors. As soon as this is done (if at all) I shall consider it my duty to study the same, and to advise to the best of my ability the debenture stockholders whose collective interests I now represent. I shall at all times be anxious and ready to give every debenture and debenture stockholder all the information in my power."

Woolwich Mains.—The Woolwich District Electric Light Company has given notice to the London County Council dated May 4, 1893, of intention to lay mains and construct transformer and inspection boxes in Globe-lane, High-street, Hare-street, Powis-street, Green's-end, Beresford-square, Wellington-street, Thomas-street, and New-road. The Highways Committee report that these works are the same as those referred to in the previous notice of the company, which were formally disapproved by the Council on March 21 on account of insufficient information having been supplied. Further particulars have since been given by the company, from which it appears that the company proposes to run in 2¼in. cast-iron pipes from its generating station primary cables carrying an E.M.F. of 2,000 volts to transformers placed in the streets, and thence low-tension mains will supply the houses. The committee think that subject to proper conditions approval may be given to these proposed works, and recommend that the sanction of the Council be given to the works referred to in the notice upon condition that the mains be laid under the footways wherever it is found practicable to do so; that all the street boxes be constructed under the footways: that the inside width of the transformer-boxes be reduced to 18in.; that the primary cables be run in the lower pipe and the secondary in the upper; that the transformer terminals be fixed on separate porcelain bases secured to the wood from below; that wood fillets be fixed on the top of the terminal board and so placed as to lessen the risk of short-circuiting; that a second wooden cover extending to the brickwork on each side be placed on the top of the transformer-boxes; that the mode of construction of, and the materials to be used for, the upper covers of the street boxes be subject to the approval of the Council's chief engineer, and be carried on a course of 3in. York stone; and that the company give two days' notice to the Council's chief engineer before commencing the works in any of the streets referred to in the notice.

Hastings.—At the quarterly meeting of the Hastings Town Council last week, the Public Lighting Committee reported they had had under consideration the matter of the desirability of lighting the Town Hall and the Brassey Institute by means of the electric light. They delegated the matter to a sub-committee of their body for consideration and report, and received from them the report presented, which they recommended should be adopted. The sub-committee reported that they had been in communication with the Hastings and St. Leonards Electric Light Company, Limited, with a view of ascertaining the cost of installing the light in portions of the two buildings, and find that the company will supply and fit up all necessary cable, wire, casing, switches, fuses, cut-outs, and other requisites to base of fittings, for lamps up to 50 c.p., for the sum of 16s 8d per light, and furnish plain pendants for same at 6s. 9d. each, and for 100-c.p. lamps at 20s. per light, and 9s. 9d. each for plain pendants. Electroliers, brackets, and ornaments would be charged for according to design and quality chosen. The cost of installing the light in the Town Hall, based on the figures quoted, would be £63 9s. 10d., and for installing the light in the rooms at the Brassey Institute £40 15s. The sub-committee have fully considered the terms, and recommended that an order be given to the company to instal the light in the portions of the buildings specified. The Mayor moved the adoption of the report. In that Town Hall there were several offices, which, for about four months in the year, became insufferably overheated by the combustion of gas. With regard to the cost, he thought he was right in stating that the excess of expense on electric light over that of gas would be 25 per cent. Referring to the reference library, he thought there could not be two opinions as to the damage done to the covers of books through gas. Moreover, he considered it was incumbent upon them, as the Corporation, to set a good example as to the consideration of the health of their officials, and they could do that best by giving them electric light to work by instead of gas. They ought also to have electric light in their committee-rooms. Surely if members of the Council spent so much time in the interest of the ratepayers, the burgesses ought not to object to allowing them the electric light for their comfort whilst attending to the town's affairs. Councillor Duke seconded, on the grounds that it would be more healthy. He had had experience of being in small rooms, and could testify to the superiority of electric light over gas. He also advocated having electric light in the committee-rooms. A long discussion ensued, and some amendments were moved, but the resolution was eventually carried. The Public Lighting Committee also reported that they received from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, formal notice of the intention of the company to extend their trunk main, comprising eight 2in. pipes, from the company's works in Earl-street, *viâ* South-terrace and Queen's-road, to the junction of Robertson-street and Harold-place. The committee recommended that the formal approval of the Council be given to the works as shown on the said plans, and described in the said notice. This was agreed to. The Lighting Committee instructed the town clerk to intimate to the Hastings and St. Leonards Gas Company that, in view of the contract entered into with the Hastings and St. Leonards Electric Light Company, Limited, for the lighting, as from 1st October next, of the Front Line, between the Fishmarket and Grosvenor-gardens, by means of electric lamps, the Council will probably not require the gas lamps between these points lighted after that date, but one clear month's formal notice of intended discontinuance will be given to the company in due course. The report was adopted.

Kidderminster.—At the Kidderminster monthly Town Council meeting the Law Committee reported that on June 15 the several proposals for the transfer of the Kidderminster electric lighting provisional order, which had been received from the various companies, were submitted to them, together with other information. After full consideration it was thought advisable to postpone taking any further steps for a period of some months. The committee met again on November 22, when a letter from Messrs. Dyson and Co., parliamentary agents (who were employed by the Town Council in obtaining the provisional order, with regard to applying for an extension of the time for executing works of supply in the compulsory area was read, and the town clerk was instructed to further consult them by interview, to make enquiries with the view of the employment of an expert to advise upon the terms offered for a transfer of the provisional order, and to ascertain if the British Electric Installation Contractors, Limited (from which proposals had been received), were prepared to reopen negotiations. Mr. A. Bromley Holmes, C.E., of Liverpool, was eventually selected to advise the committee. A further meeting was held on December 13 last, when it was resolved to send a copy of the proposal of the above company to Mr. Holmes and ask his opinion upon it, and ascertain what he would charge for visiting Kidderminster, making a report, and advising the Council. Mr Holmes offered to inspect the compulsory area and make a report for 20 guineas and his travelling expenses; and this having been agreed to, he came to Kidderminster and has since sent in a report to the committee, in which he advises the adoption (as the most suitable system for Kidderminster) of a low-tension direct current with a battery of accumulation to supply the current during the hours of small demand when it would be uneconomical to run the engines. He states that many corporations, including those at Brighton, Bradford, Bristol, Derby. Glasgow, Hull, and Manchester, are now undertaking the supply of electricity, whilst the supply is provided by companies in London (except St. Pancras), Liverpool, Birmingham, Preston, and Newcastle. He remarks that as electric lighting is, comparatively speaking, a new business, it is consequently possible that improvements may from time to time be made which will depreciate the value of the plant and appliances in use at the present time. Mr. Holmes also points out that no substantial company would enter into an agreement for a transfer of the provisional order, except on condition of charging such rates as would allow them a suitable return on the capital employed; and, in the event of a compulsory purchase, not only the capital expended, but a considerable addition thereto as compensation, the question, however, being largely a matter of finance depending upon local considerations. The costs of laying mains in all—or nearly all—the streets in the compulsory area, to erect buildings, and put down plant capable of supplying 3,000 16-c.p. incandescent lamps, the buildings being so arranged as to admit of extension, is estimated at approximately £15,000. Taking into consideration the moderate price charged for gas in Kidderminster, and the nature of the area of supply, Mr. Holmes does not anticipate that there would be at first a large demand for electric light, as the cost of electricity would be at least double that of gas. When the incandescent lamp patent expires in November next, much cheaper lamps of higher efficiency will be obtainable, and the time is probably not far distant when the electric light will compete with gas at equal price Mr. Holmes further considers it reasonable to expect that within 12 months of commencing the supply the profits would be sufficient to pay interest on the capital employed, and the business a steady, increasing one The committee, with the view of estimating whether the probable demand for electric lighting would justify the Town Council in taking the matter up, recommend that a circular be sent to all probable consumers in the compulsory area, enquiring whether they are prepared to accept a supply at an estimated cost of 6d. per Board of Trade unit, or equal to 5s. per 1,000ft. of gas. When the result of this application has been obtained, the committee will be prepared to make a further report to the Town Council. The Mayor, in moving the adoption of the report, said the report was so full there was very little for him to add. The committee recommended the adoption of the same course as was taken at Worcester. Mr. Parry seconded, and the motion was carried.

London Mains.—The Highways Committee of the London County Council report that they have considered notices from the London Electric Supply Corporation of intention to lay mains, consisting of concentric lead-covered cable drawn into iron pipes in Brewer-street, Air-street, Sherwood-street, Denman-street, Little Pulteney-street, Archer-street, Great Windmill-street, Upper Rupert-street, and Shaftesbury-avenue; to lay distributing mains in Great Pulteney-street, Bridle-lane, Upper and Lower James streets, Golden-square, Upper and Lower John streets, Warwick-street, Leicester-street, Beak-street, King-street, Foubert's-place, Carnaby-street, Marshall-street, Little Argyll-street, Argyll-street and place, Ramilies street, Great Marlborough-street, Poland-street, Berwick-street, Noel-street, Portland street, Broad-street, Edward-street, Peter-street, and Lexington-street, in the parish of St. James, Westminster. They see no objection to the proposed works, but are of opinion that the mains in Shaftesbury-avenue should be laid in the subway of that street; and recommend (a) that the sanction of the Council be given to the works referred to in the notices upon the following conditions: That the company do give two days' notice to the Council's chief engineer before commencing the works, in the carrying out of which only one side of any thoroughfare shall be obstructed at one time; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material, as the case may be; that no pipes of larger size than 5in. shall be used; that no street boxes shall be constructed until the positions for, and the mode of construction of, them shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering. (b) That the clerk be instructed to forward to the company a notice requiring it to lay the mains for Shaftesbury-avenue, referred to in the notice dated April 17th, 1893 (registered No. 374), in the subway of that thoroughfare. They have also considered a notice from the Westminster Electric Supply Corporation of intention to lay mains on both sides of Down-street, and in Pimlico-road, Union-street, Graham-street West, Whitaker-street, and Westbourne-street. The proposed works are unobjectionable, and the committee recommend that the sanction of the Council be given to the works referred to. A notice has been given by the Kensington and Knightsbridge Electric Lighting Company of its intention, immediately upon the passing of the Kensington and Knightsbridge and Chelsea Electric Lighting Bill, to lay mains across Brompton-road for the purpose of connecting the company's system with that of the Chelsea Company to be transferred under the Bill. This notice is somewhat informal, as the company will not until after the passing of the Bill be entitled to give notice for works in the South Kensington area. As, however, the committee see no objection to the proposed works, they think the works may be sanctioned, but that the notice of approval should be retained until the Bill shall have become law. They recommend that the sanction of the Council be given to the works referred to in the notice, but that the clerk be instructed not to send the notice of approval until the Bill shall have received the Royal assent. They have considered two notices from the House-to-House Electric Light Supply Company, the one of intention to lay mains in 3in. cast-iron pipe, in a part of Lexham-gardens, and the other of intention to lay mains in a part of Collingham-gardens. The proposed works are unobjectionable, and they recommend that the sanction of the Council be given to the works referred to upon condition that the company give two days' notice to the Council's chief engineer before commencing the works; that no pipes of a larger diameter than 6in. shall be used; that the street boxes shall be of the pattern approved by the Council; and that as an additional precaution against accident through defective insulation of the mains each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth. A notice has been given by the Electricity Supply Corporation of intention to lay mains across and along a part of King William-street to the "Final" public-house. The mains will be laid in three-way Callender casing, and two street boxes will be constructed on the south footway of the street. To these works the committee see no objection, but they are of opinion that when once commenced they should be carried out as expeditiously as possible. They recommend that the sanction of the Council be given to the works referred to in the notice, upon condition that the company give two days' notice to the Council's chief engineer before commencing the works; and that the works when commenced shall be carried on continuously both by day and night until completed; that the concrete floor of the street boxes be 9in. thick, that the York stone at the top be 4in. thick, and that the longitudinal girders (if used) in all the boxes be laid on 3in. stone templates, the full thickness of the brickwork, which shall be 9in. thick.

PROVISIONAL PATENTS, 1893.

MAY 1.

8722. **Improvements in or relating to dynamos or electric motors.** Alfred Julius Boult, 323, High Holborn, London. (*Octave Patin and Léon Levavasseur, France.*)

8742. **Improved methods of and apparatus for transmitting signals or electric impulses.** David Young, 11, Southampton-buildings, Chancery-lane, London. (Charles Cuttriss, United States.) (Complete specification.)

MAY 2.

8802. **Improvements relating to the electric lighting of railway carriages and other vehicles.** Oliver Schofield Ruddock, 45, Southampton-buildings, Chancery-lane, London.

8808. **Improvements in electric accumulators or storage batteries, partly applicable as a constant primary element.** Heinrich Lehmann, 33, Chancery-lane, London. (Complete specification.)

8812. **Electrical apparatus for raising the shutters of telephone indicators.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (Société Générale des Téléphones Reseaux Telephoniques et Constructions Electriques, France.)

MAY 3.

8908. **Improvements in apparatus for the electrolytical decomposition of brine and other liquids.** Malcolm Guthrie, 46, Lincoln's-inn-fields, London.

MAY 4.

8925. **Improved electrical time transmitter and alarm.** Henri Louis Leconte and Louis Adolph Meyer, 52, Chancery-lane, London.

8952. **Improvements in electric accumulators.** Friedrich Wilhelm Ellerman, 191, Fleet-street, London. (Complete specification.)

8958. **Improved apparatus for applying electricity to the body.** Camilo Giacomo Biaggio Rigola, 4, South-street, Finsbury, London.

MAY 5.

8969. **Improvements in switching arrangements at telephone exchanges and subscribers' instruments.** George John Somerville and Robert McLean, 102, Portland-street, Manchester.

MAY 6.

9090. **Improvements in or relating to the parallel working of alternating electric current generators specially applicable in connection with gas and similar engines.** Wilfred Swanwick Boult and Cedric Randal Boult, 323, High Holborn, London.

9092. **Improvements in or relating to the "capping" of electric incandescent or glow lamps.** Wilfrid Swanwick Boult and Cedric Randal Boult, 323, High Holborn, London.

9126. **An electric arc lamp improved method for maintaining a uniform arc.** John Joyes, 3, Excelsior-terrace, Saunders-road, Plumstead, Kent.

SPECIFICATIONS PUBLISHED.

1892.

7226. **Electric treatment of metal, etc.** Hoho and Lagrange.
7833. **Electrical metronome.** Walker and Hampshire.
8385. **Electricity meters.** Taylor.
8537. **Electric switch.** Langdon.
9185. **Electric wire couplings.** Shiels.
9500. **Electric switches.** Munroe and McFarlane.
9536. **Electric distribution.** Allison. (Mailloux.)
10388. **Secondary batteries.** Freund and Bristol.
10524. **Electrical insulating sheet.** Dyer.
11087. **Galvanic batteries.** Wise (Rosati and others.)
19690. **Incandescence electric light circuits.** Enholm.

1893.

3200. **Electric conducting wires.** Schomburg.
4363. **Electric railways.** Thompson. (Bates.)
5339. **Electric motors.** Lundell and Johnson.
5486. **Dynamo-electric machines.** Meston.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¾
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6¼
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Institution.—The discussion on Mr. Sayers's paper will be continued next Thursday, the 25th inst.

Electric Canal Propulsion.—Boats on the Erie Canal are to be propelled by electric motors fed by trolley wires.

Military Telephones.—M. Ch. Haubtmann reads a paper to-night before the Société des Ingenieurs Civils on "The Military Telephone."

Long-Distance Telephony.—It is stated that a telephone line is to be laid from Halifax, Nova Scotia, to Vancouver, a distance of 3,000 miles.

Electric Bleaching.—One of the largest paper-making concerns in the States is now putting in electric bleaching plant for bleaching wood pulp.

Technical Journalism.—A new idea is started by the *Engineering Magazine*, who, before its articles, gives a sketch of the standing and experience of each of the writers for the month, so that readers may know the value of the opinions expressed.

Dynamo and Transformer Design.—On Tuesday, May 30, Mr. Swinburne will deliver the first of a series of lectures on "The Design and Construction of Dynamo Machines and Transformers" to the students of the Electrical Standardising, Testing, and Training Institution at Faraday House.

Telephoning Stock Exchange Prices. — The Austrian Minister of Commerce has introduced a system of telephoning Stock Exchange quotations on the Vienna Bourse to subscribers to the State telephone service, on payment of a small charge. Subscribers can either have telephoned the prices of the whole or any particular class of securities or shares.

Personal.—On Wednesday afternoon, at the General Post Office, a timepiece, illuminated card, and purse of money, subscribed by the officers and men of the electric light staff, was presented to Mr. T. Heather (who has been foreman for many years) on the approach of his marriage. The presents were handed to Mr. Heather by the superintendent, Mr. I. Probert.

Bursting of an Armature.—An armature in the Thomson-Houston factory at Lynn, Massachusetts, burst on April 9. One piece struck a student named Carter in the right eye, causing the loss of this eye. His left arm was also broken, and had to be amputated. Considering the great speed at which armatures revolve, it speaks well for the goodness of their manufacture that we do not hear more of such accidents.

Train-Lighting.—Mr. W. M. Acworth, in the *Engineering Magazine*, says: "The Americans are, I think, ahead of us in the matter of carriage-lighting. We have a good many trains lighted with electricity, a light which, from the passengers' point of view, leaves nothing to be desired; but it does not seem likely to come into general use, and will probably remain with us, as in America, a luxury and an advertisement for a few crack trains."

Electric Power Transmission.. — The electric transmission plant at Pomona, California, already mentioned, is now in full operation. Dynamos at 1,000 volts, driven by Pelton wheels, deliver current to transformers which raise the pressure to 10,000 volts, and circuits of bare wire take the current to Pomona and San Bernardino, the latter being 28 miles from the waterfall. The head of water used is 400ft., and the speed of dynamos 600 revolutions.

Goebel.—Heinrich Goebel is the central figure in electric circles at the present moment in America. The *Electrical World* gives two portraits and a sketch of his life. Goebel is a thoughtful, almost noble-looking man, in his portraits, with a high-domed forehead, strong nose, bushy brows, and white hair and beard. He was born on April 20th, 1818, in the village of Springen, a small place near Hanover. He is now therefore 75 years old. He was trained as a watchmaker, and came to the States in 1848. He has had 14 children, seven of whom are now living.

Novak Lamp.—New lamps are the order of the day in America, the greatest activity being apparent in manufacturing circles to get hold of the market again. Besides the Westinghouse, a new lamp, designated the "Novak," will be shortly open to delivery. This lamp is the invention of Mr. Waring. There is "no vacuum," as its name is supposed to imply, the place being taken by a dense, evil-smelling gas, whose valuable properties are said to be unknown except to the inventor. Be this as it may thousands of orders have poured into Boston for these lamps.

Census Machine.—M. Cheysson has recently brought before the attention of the Académie des Sciences the electric census machine of Mr. Hollenitz. The machine tabulates the varied details of census papers by electrical contacts, which are made through stamped holes to the number of 240 in various combinations. The machine has already been described, and has been favourably reported upon in America. Its introduction into European statistical departments is probably only a matter of time, as its use saves an immense amount of trouble in classifying and counting.

Telephoning along Telegraph Wires.—An apparatus for telephoning simultaneously along telegraph wires has been constructed by Mr. J. von Demetzky, of Budapest. By permission of the Hungarian Minister of Communications, the method has for some time been tested on the telegraph line from Budapest to Szegedin, a distance of 124 miles. The results were satisfactory. The apparatus can easily be inserted in a telegraph circuit and used at once. It is said that simultaneous telegraphy along the wire does not in the least interfere with telephoning, and that the effects of induction and all disturbing noises are completely removed.

The "Alva."—Mr. Vanderbilt's new yacht, built by Messrs. Laird Bros., of Birkenhead, to replace the "Alva," sunk by collision last year, is 310ft. long, 39ft. 3in. beam, and 25ft. 6in. deep, and her tonnage is about 2,400. She will be driven by two sets of triple-expansion engines of about 4,500 i.h.p., and is expected to develop a speed of 15 knots under natural draught and 17 knots under moderately forced draught. The new yacht will of course be fitted with all the latest modern improvements in the way of electric lighting and steam appliances, while her internal arrangements and decorations will be of the most luxurious character.

The World's Fair Electric Railway.—The elevated electric railway at the Chicago Exhibition is three miles long, on a double track with loop ends. There are 10 stations, approached by an incline. The generator is a 1,500-kilowatt multipolar machine, the largest in the country. It is driven by a 2,000-h.p. engine. Its shaft weighs 65 tons. There are three 500-kilowatt and one 200-kilowatt generators, in addition, with corresponding engines. There are 18 trains of four cars each, the first car in each having four electric motors, of a total of 530 h.p. for each train. Each car seats 96 passengers. The complete trip can be made in 40 minutes, including stops.

Ceylon Cables.—Telegraphic communication between India and Ceylon was carried on by two cables from Ramiaswaram in India to Talmanaar in Ceylon, one insulated with guttapercha and the other with indiarubber. The first had become absolutely useless, while the second, though workable, was out of order. Mr. A. L. H. Palmer, superintendent of the Madras Government telegraphs, has recently repaired the faults, cutting out the bad places and replacing with good cable. The work was difficult, taking from March 17 to April 4. It was carried out with the aid of coolies, who slept on rafts outside the steamboat.

Gas-Engine Dynamos.—The employment of dynamos direct driven by gas-engines appears to be on the increase on the Continent. In the *Revue Technique des Inventions Modernes* the Koerting gas-engines used in this way are illustrated. The greatest regularity is given with a single cylinder by having a variable admission. An explosion never misses at each revolution, even when running quite light. Direct-driven dynamos give a perfectly satisfactory light for arc and incandescent lamps. No other gas-engine, it is claimed, even those with two cylinders, can show such absolute regularity of speed: the constancy is such that the tachometer needle remains practically still.

Public Lighting at Munich.—The central part of Munich, the capital of Bavaria, will be lighted shortly by electricity. It has been decided to utilise the water power at two places near the town, and this interesting installation will be carried out by Messrs. Schuckert and Co., of Nuremberg. Three hundred arc lamps are provided for, and by means of accumulators the town hall will be lighted with 1,800 incandescent lamps of 16 c.p. each. Munich, therefore, as regards the street-lighting, will surpass every other town on the Continent except Milan; but as an early extension to double the original number of arc lamps is contemplated, Munich will then take the first place with respect to street-lighting.

Goebel Lamps.—The credit for the fight in the incandescent lamp case in which Edison has been tripped is due to Mr. Rhotehamel, president of the Columbia Incandescent Lamp Company. He brought forward Goebel's claims once more, staking his all on the fight—and won. Now his factory is in full work again. "As for Goebel," says our New York namesake, "the old man must feel repaid for many years of contempt and neglect. It has seemed to us that there is very little doubt of Goebel's early, untimely, and crude work. It will now take a great deal to disprove his claims. Judge Hallet holds that the burden of the case is on the complainants—in the meantime the art is practically free. We think it will stay so."

Meters.—In a recent discussion before the American Institute of Electrical Engineers on his paper on "Electric Recording Meters," Mr. Haskins referred to the Board of Trade tests of meters. The Board of Trade, he said, was evidently satisfied with instruments which certainly showed considerable error, but insisted more on certain details of mechanical construction. Of course a certain accuracy was required, but they were more inclined, he thought, to dictate as to the character of mechanical construction, facilities for installing, and similar details than they were as to what was really the essential thing—what the meter should record. "It was a great surprise to more than one meter man." Methods of sealing were given great importance.

Woodhouse and Rawson.—Compulsory, not voluntary, liquidation is the judge's decision, and the judge is *right. Voluntary liquidation* means that the method by which this company was conducted was to be ignored, and that not even a scapegoat was to be found. Compulsory liquidation ought to mean an investigation into the payment of large sums by the creation of debentures. Was the payment of that money justified? If not, those who received those debentures will have to disgorge. It is not fair to ordinary trade creditors that debentures created in payment of these moneys should rank against the estate at all, and if the official liquidator finds that some £70,000 or £80,000 was paid—£50,000 of it in debentures—in error, the trade creditors will probably get something out of the ruin.

Electric Painting Machine.—An illustration is given in the *Scientific American* for April 29 of the electric painting-machines used at the World's Fair, which we have already mentioned. The paint is squirted on the woodwork, through nozzles attached to flexible tubes, by means of electric pumps connected to the barrels of liquid paint. A rotary engine, invented by Mr. T. G. Turner, of New York, driven by a 5-h.p. electric motor, provides compressed air. This engine furnishes the required pressure in a uniform manner without the air-chamber necessary to overcome pulsations, which are used in reciprocating compressors. One machine furnishes spray for two nozzles. There are now 14 machines at work, each with three men. A comparative test showed that one painter with brush did eight squares a day and the machine covered 20 times this, requiring, however, two nozzle-men for each machine. The material used is a little more, in the proportion of 21 to 20; but with a saving in time and labour of 20 to 1, this loss in material is scarcely worthy of consideration.

Resistance of Mercury.—MM. Kreichgauer and Jager, says the *Bulletin de l'Electricité*, have published their researches on the thermic variation of the resistance of mercury. Their results give a formula very nearly approaching that of M. Guillaume, presented to the Academie on September 12th, 1892. M. Guillaume has shown that the two are more nearly in accord than even seems at first sight. The new coefficient x is 0·0008884; it differs by $\frac{1}{5000}$ only from that of M. Guillaume, and this is the more remarkable in that the measurements were made with mercury purified by different processes, contained in glass vessels of different composition. M. Guillaume made his tests by two methods derived from that of the Wheatstone bridge, while at Berlin the crossed shunt was used. The French experimentalist used Benoit contacts, modified; the German standardisers used contacts soldered into the glass. The agreement of the results after the great number of tests made shows that confidence may be given to mercury standards under proper restrictions.

Steam from Slag.—The enormous amount of heat habitually wasted in cooling molten slag has incited Mr. Ashcroft, electrical engineer at the Proprietary Mine, Broken Hill, to working out a scheme for generating steam by this means. The process is described by the correspondent of the *Adelaide Advertiser*, as follows: "Briefly speaking, the boiler, or receptacle for the water, has running through it from top to bottom slightly funnel-shaped pipes, something after the style of a big candle mould, in fact. The molten slag is poured into these receptacles, and communicates its heat to the water. When the slag becomes solid a door at the bottom of each receptacle is opened, the slag is knocked out, and the hole filled again. The apparatus has been tried, 100lb. pressure of steam being raised. If Mr. Ashcroft's ideas can be fully realised, the value of the process will be enormous, but it is too soon yet to give a decided opinion one way or the other. So far, the intense heat of the slag has been wasted. At first Mr. Ashcroft poured water on the slag, but it was found that the stuff caked hard all round, and remained molten inside. Then he struck the idea of communicating the heat after the manner of the fire under the boiler—that is, getting all the benefits without the slag and water coming in contact one with the other."

Railway Electricity.—Last week, at the Birmingham Municipal Technical School, Mr. W. H. Whitehouse, lecturer on telegraphy and telephony, delivered the first of a course of eight lectures on the "Application of Electricity to Railway Working." The lectures have been specially arranged for the instruction of telegraph clerks, the linemen who repair the wires, and the signalling-men employed by the London and North-Western, Midland, and Great Western Railway Companies, but, in addition, postal telegraph clerks and telephone clerks are also allowed to attend. The first lecture dealt with the construction and management of the various batteries used—Léclanché, Daniell, and Fuller—and methods of detecting and remedying faults were given. In the future lectures Mr. Whitehouse will describe the best method of grouping up cells, the construction and management of the instruments used in telegraphing and telephoning, etc., one of the chief subjects being that of block signalling and the interlocking of points. The lectures are mainly experimental, and are made interesting by numerous practical illustrations.

Electric Production of Aniline.—MM. Coblentz frères, of Paris, have developed a method of producing aniline from nitro-benzine electrically, which is described in the *Revue de Chimie Industrielle* and in the *Moniteur Industrielle* (May 9). A cylinder of double thickness is used, two metres long, the liquid in which is agitated by a screw. Pieces of zinc are arranged inside, and a solution of sulphate of zinc is first introduced and allowed to act, the copper being finely deposited on the zinc. The solution is emptied and a mixture of two-thirds nitro-benzine and one-third water is introduced, and the screw set in work so that the liquid goes up outside and descends inside the axis. The inner space is heated by steam. The electric effect takes place in the body of the liquid, and is complete in 12 hours. After resting an hour the aniline is decanted. The treatment of 100 kilogrammes of nitro-benzine requires 150 kilogrammes for disengagement of the hydrogen, plus 25 kilogrammes for decomposition of the sulphate and acid cleaning, or a total of 175, say, 200 kilogrammes per 100 kilogrammes of aniline obtained, which is not more economical than present processes; but the aniline is obtained in a state to be used without preliminary distillation on lime, according to usual processes. The zinc-copper couple is not very practical. But the hydrogenation of the nitro-benzine by decomposition of water by the current is quite practical and economical, and it is in this direction that the attention of manufacturers should be given. The Germans are using such methods with good result. Toluidines and xylidines can be treated in the same way.

Students' Engineering.—We have received from Mr. G. W. Tunzelman, B.Sc., M.I.E.E., etc., principal, the prospectus of the "Electrical and General Engineering College and School of Science," Penywern House, Earl's Court. Mr. Capito, late of the Hanover-square School of Electrical Engineering (now closed), has joined the enterprise, and Mr. T. W. Nicholson, B.Sc., is chemical lecturer. There are French and German masters (usual style), and a medical officer to the college. The objects are to train engineering students in general scientific principles, and provide preliminary training for the Central Institution and Cooper's Hill. The course is set forth in detail, and ranges from "ordinary rules of arithmetic, the first four books of Euclid, motion of a point," etc., to the "elements of permutation and the binomial theorem." The first year of electricity begins with "elementary electrostatic and magnetic phenomena," up to "absolute units." Chemistry, geology, patternmaking, and chipping are also included, with French and German. A second year's course includes drawing, design of boilers, dynamos, and motors; integral calculus. A workshop course, with machine tools, can be given in the third year, and "students joining now have an opportunity of gaining experience in carrying out a lighting and power station" at the college. The course seems comprehensive, and so far practical; but the fee seems *diablement chèr*. First, 260 guineas for the three years' course; add 100 guineas a year for 40 weeks' residence, 20 guineas for revision, and, say, £50 extra for spare cash, and we get £700 as the outlay for a young electrical engineer in embryo trained to join the Central. The advantages of a private college have to be paid for; but a long list of references to parents and guardians shows the college to be working under high auspices.

Electric Production of Baryta.—M. Ch. Taquet, in the *Bulletin* de l'Association des Chimistes, describes his process of producing baryta electrolytically, and also the carbonic acid of the precipitated carbonate, in a method of extracting sugar from molasses. If in a vessel, separated into two compartments by a porous diaphragm, a solution of chloride of barium is electrolysed, using as cathode a plate of copper, and as anode a plate of iron, hydrogen is seen to be given off at the negative pole, while the baryta which is disengaged is dissolved as it forms, while the chlorine at the positive pole gives protochloride of iron, which is used, as will be described, to regenerate the chloride of barium. After a certain time there will be on one side a solution of baryta, and on the other a solution of protochloride. The baryta solution is used in the ordinary way to separate the sugar from molasses by precipitation, washing, carbonatation, etc. The baryta finally passes, therefore, into a state of carbonate. This is drawn off; the solution of chloride of iron is brought to boiling, the precipitated carbonate of baryta is added, and this gives rise (1) to carbonic acid, which will serve for further carbonating, (2) to chloride of barium, and (3) to insoluble protoxide of iron ($BaOCO_2FeCl = BaCl + CO_2 + FeO$). The chloride of barium is again put into the electrolyte to give once more BaO and FeCl. The protoxide of iron separated by filtration can be used as ore or calcined. The use of a soluble anode has thus a great advantage of giving a salt capable of regeneration and of diminishing the work done by the current. The E.M.F. is only 1·5 volts. Two kilogrammes of baryta, calculated in the state of BaO, are given per horse-power hour, even on a small scale. The sugar extracted in this way would be very cheap, if water power were available. Almost all the sugar can be extracted without caustification of the carbonate of baryta. The same reactions take place with strontium instead of baryta.

Telegraphing to Trains.—Many persons can remember the case, not so very long ago, when all the world stood horror-stricken at the awfulness of an accident on the Riviera. The station-master despatched a train on the wrong line to its doom of rushing into another train and crashing over the precipice. Bells were rung, and people shouted, but there was no means of stopping the train wrongly started, and the station-master shot himself as he heard the crash. A similar incident happened at Hampton Wick two or three years ago, not under quite such dramatic circumstances. Not only in such cases, but in many others, constantly occurring, is the necessity of being able to telegraph to trains in motion demonstrated to railway directors. Attempts have been made at various times; Edison once bent his ingenious mind to the problem, and the result was widely reported, though nothing further has been done of late. We now hear that in Algeria experiments have been satisfactorily made on telegraphing to trains in motion. The trials took place on the railway running to the mines at Mokta-el-Hadid, and were "fully successful." The tests included (1) the exchange of telegrams between a train in motion and the station; (2) between two trains in motion; (3) the telegraphic stoppage of a train: started and out of sight, it was ordered to stop, start again, and return to the station; (4) two trains started on the same track, and approaching each other at an express speed at the rate of nearly 1¼ miles a minute, avoided collision by mutually and automatically warning each other by indication of their direction, and the position according to kilometre posts which they had attained. Every case in practice was tried, and with success. Though no details of the signalling arrangements are yet given, M. Etienne, the inventor, seems to have attained results which will commend themselves to railway engineers. The fact that every train can be kept within actual call of the station at any point in its route is evidently most important. The whole question, however, is one of cost of signalling and practicality of the arrangements in ordinary work. It is to be hoped that the tests of M. Etienne will not be overlooked, for as rapid long-distance railways are established, these, at least, might adopt the most scientific means of controlling their trains.

Storage Batteries.—There is an amusing article in the *Western Mail* for the 11th in the true Yankee style—new discovery, startling headlines, "on the eve of solving a problem," "result of 11 years' toil," and so forth. It seems that the editor had sent home a description, taken from the *St. Louis Republic*, of a new storage battery—the Logan. President W. T. Anderson was interviewed, and claimed that Chas. H. Logan's inventions were going to revolutionise the industry. In the Logan battery the plates consist of common parallel, vertical lead tubes, with narrow slots opening into them their full length. The red lead is placed in these tubes, the slots being too small for the lead to fall out. The battery is hermetically sealed. It can be left, and "the chemical action that goes on increases its power." Mr. Johnson, the manager, is so confident of success that he will guarantee to construct a battery not heavier than a locomotive and tender, to pull a train from St. Louis to Chicago in one-third less time than now occupied. Mr. Anderson is firmly convinced that in five years the Logan battery will be whirling cars along on the great trunk lines and driving machinery in mills! The *Western Mail* man was naturally rather startled at this, and interviewed several local electrical engineers. Mr. G. Southey, their own electrician, was first attacked, but although he knew all about electric registering machinery, he would not say much on the Logan battery, save that he did not see much good in it. But he mentioned an inventor in Cardiff itself, Mr. Emmanuel Hancock, of 28, Eisteddfod-street, who had an invention of his own in this direction. Mr. Hancock was interviewed. His batteries are of solid plates. They will be half the weight and one-fourth the cost of present cells. Only two plates are needed for each cell, and they may be of any size and thickness, and up to any capacity. Mr. Hancock has been working on his battery for 11 years. It is to be on the market in three months. The interview concludes very suggestively, though this may be quite accidental: "You don't think much of this Yankee battery?" asks the interviewer. "No, I do not," replies the solid-plate man; "I remember a man booming a plate which he claimed to be indestructible, but it came to nothing after all."

Towing by Electricity.—Mention was made in a previous issue of a system of towing by magnetic adhesion devised by M. de Bovet. This method has recently been tested on board the "Ampere," at Saint-Denis on the Seine. This boat is a screw steam-tug of 150 h.p., provided with plant for cable haulage from a chain laid in the river, similarly to the system generally used in France for ascending rivers having a rapid current. She is 106ft. in length, 18ft. in width, 9ft. deep, and has a draught of 6ft. 4in. when towing, and was built by M. H. Sâtre and electrically equipped by MM. Sautter, Harle, and Co. The novelty of the system lies in the magnetising of the hauling pulley to obtain the required adhesion. The pulley consists of two cast-iron plates connected together by means of bolts. Between them is arranged an annular cavity, which is partly filled with a coil of wire; it is, in brief, only an ordinary solenoid having an iron core, the ends of which forming pole-pieces are opened out and drawn together in such a manner as to constitute the two sides of the groove of the pulley. The bottom of the groove is closed by a bronze ring with indiarubber joints, which prevent water from getting to the coil. The current from the dynamo on board reaches the wire coil by means of wires arranged in the hollow of the shaft along an inclined channel made in the plates, which form the poles of a powerful electromagnet. On engaging in the groove, the chain simultaneously bears on the two poles and short-circuits them. During the experiments an old chain, reduced by usage to a weight of about nine kilogrammes (20lb.) per metre, gave an adhesion of from six tons to six and a-half tons. It is supposed that with a new chain, of 15½ kilogrammes (34lb.) per metre, 10 tons adhesion would be obtained, or twice the tractive power of the towing service on that part of the Seine served by the Compagnie de touage de la Basse-Seine et de l'Oise. The anchorage of the chain only causes a loss of 10 per cent. of the bearing power. The maximum current to be used with the new chain, that beyond which an increase in the bearing power cannot be ascertained, is 48 amperes, corresponding to 37,000 ampere-hours, and to an expenditure of 4·5 h.p.; even with the old chain an adhesion of six tons was obtained, with a current equivalent to only 3 h.p. By means of two sets of gearing, the engines can either drive the screw direct when developing 150 h.p. at 150 revolutions, or the towing apparatus when giving from 60 h.p. to 80 h.p. at 90 revolutions. There are two boilers in the stern of 150 h.p. each, and there are two rudders, as in the case of other towing boats. Both at the stern and the bow the chain from the river passes between guides, then between vertical rolls, and next three-quarters way round the towing pulley, the ingress and egress from which are regulated by two guide rollers symmetrically arranged and mounted in such a manner as to allow of the chain being readily put into position or thrown into the water. M. de Bovet has provided special arrangements, including a magnetic brake and a pit for the slack experienced in bends, for dealing with the chain after leaving the second guide rollers, and before being paid back into the river. The "Ampere" gave good results during the tests. When driven by the screw down stream, without any barges in tow, a speed of 11 miles an hour was attained, when the engines developed 170 h.p. This is considered good for a boat of this kind. When going up stream the results showed that an absolute speed of 9¼ miles an hour could be obtained, with the engines giving from 145 h.p. to 150 h.p. This system, which is employed by the Compagnie de touage de la Basse-Seine et le l'Oise, is expected to effect a great change in towing on important waterways where the current flows at a rapid rate.

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 481.)

The other theoretical considerations to be remembered in designing a transformer are of a more general nature, such as keeping the copper circuits of as small a perimeter as possible. The same applies to the iron circuits, as any undue length in the iron increases both the iron loss and the idle current when the transformer is unloaded. In fact, these points are so easily expressed in formulæ that there have been many attempts made to deduce practical conclusions as to the best design from these alone. The results thus obtained have not been satisfactory as a whole, and sometimes have led to mistakes in practice.

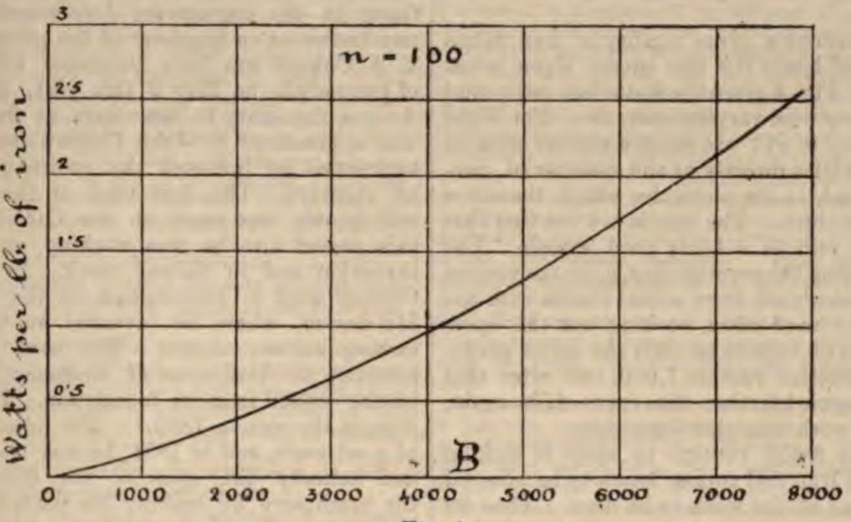

FIG. 4.

The question of the cooling surface to be allowed is one of the most vital importance. The custom of enclosing transformers in cast-iron cases tends to increase the difficulty of preventing the temperature becoming too high. The heat generated in the transformer has to pass first from it into the surrounding air inside the case, then from this layer of air into the case, and finally from the case into the surrounding medium. This triple transference is greatly assisted if oil is used to fill in the case. The oil acts by conduction and convection in carrying the heat to the case, and thus materially reduces the final temperature of the transformer. The oil is primarily said to be used for insulation purposes, but its action as a cooling agent is at low voltages the more valuable of its properties.

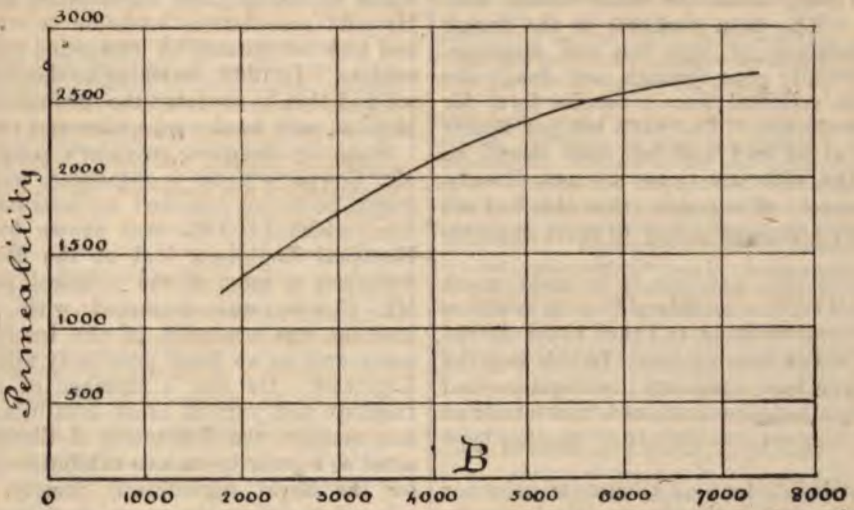

FIG. 5.

The actual design of the sections of the two copper circuits for a given loss is a problem similar to those occurring in dynamo calculation, and presents no new difficulties.

The following formulæ, which are simply deductions from the specific resistance of copper, will be found very useful in determining the sizes of the copper circuits:

If s = the section of the wire in square inches;
d = the diameter of the wire in inches;
i = the maximum current in amperes, as read on a Siemens dynamometer;
τ = the number of turns in the circuit;
π = the mean length of a turn in feet;
l = the total length of conductor in feet;
θ = the drop of volts allowed at maximum current;
r = the resistance in ohms;
g = the weight of copper in pounds.

Then for rectangular sections

$$\left.\begin{aligned} s&=\frac{i\,\tau\,\pi\,9{\cdot}2}{\theta}10^{-6} \\ r&=\frac{\tau\,\pi\,9{\cdot}2}{s}\,10^{-6} \\ g&=s\,\tau\,\pi\times 3{\cdot}85 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (3)$$

$\tau\,\pi$ can in each case be replaced in the above by l, but it is well to record the mean diameter in each design.

With wire of circular section these formulæ become

$$\left.\begin{aligned} d&=\sqrt{\frac{i\,\tau\,\pi}{\theta}\,11{\cdot}75}\;\,10^{-3} \\ r&=\frac{\tau\,\pi\,11{\cdot}75}{d^2}\,10^{-6} \\ g&=d^2\,\tau\,\pi\,3{\cdot}02 \end{aligned}\right\} \quad . \quad . \quad (4)$$

The constants 9·2 and 11·75 give the respective sizes and resistances at a temperature of about 105deg. F., which may be considered as a fair allowance for heating, and on assumption that the copper is of 100 per cent. conductivity.

If a higher temperature is allowed, or inferior copper is used, these constants must be modified accordingly.

There is, however, one other important point to be considered, and that is the question of magnetic leakage. When most transformers are tested, it will be found that the drop in volts in the secondary between no load and full load is more than can be accounted for by the resistances of the copper circuits. This is due to the fact that at full load the whole field produced by the primary does not pass through the secondary, but some portion of it is forced out by the action of the secondary current, and consequently we get a drop in volts. This is an important point, but it will be more readily understood after a trial design has been given.

It will be best to assume a given quality of iron taken from practical test, and hence the two curves given below have been prepared. Fig. 4 gives the watts lost per pound of iron at 100 frequency with varying induction. For slight alterations of frequency it will not cause a serious error to assume that the loss varies directly as the number of complete periods per second, as the plates for which the curve is drawn were 10 mils thick. The iron is not the best that can be obtained, but still is a fairly good sample. The other curve, Fig. 5, giving the permeability, μ, for the various inductions, was also calculated from actual results with the same iron, and will be used when working out the open-circuit currents. It will be noticed that the curve gradually rises till the induction reaches 7,000, and after that it is nearly flat. If carried farther the curve falls again, but it is not usual to work at higher inductions.

The following is a useful routine to adopt in making designs: First fix the iron and copper losses to be allowed from the considerations of the work to be done. Then fix roughly the dimensions of the iron circuit and calculate the weight of iron. From the iron loss obtain the loss per pound, and hence, from Fig. 4 the induction. This, multiplied by the cross-section of the iron, gives the total flux, and from formula (1) the number of turns required in each winding can then be found. Obtaining the mean length of turn approximately, the sections or diameters of the wires can be found, together with the weights for the assumed copper loss, from formulæ (3) and (4). The question then becomes one of mechanical design to get the winding arranged symmetrically with ample insulation. It will usually be found necessary to alter slightly the iron circuit, and very often the other details may require modification. The main elements in the design being fixed, the calculations of iron loss and magnetising current can be carefully gone through, and finally the whole data should be collected into a concise form for comparison with other designs. The watts lost per square inch cooling surface at no load and full load should be recorded, although the different types are not directly comparable in this respect. The results thus obtained are sure to suggest various alterations likely to effect improvements.

The most economical plan, however, is to make many designs for two outputs varying considerably so as to obtain the most economical forms for these, and then to get out the intermediate sizes by aid of interpolation. In this way the merits of any given type form a separate investigation, and the error of comparing a badly-proportioned transformer of one type with a well-designed transformer of another type may be avoided.

I propose to work out designs for a six-kilowatt transformer of three different types to explain the above method of working. The reader can then for himself try the effects of small alterations in the different circuits on the efficiency and cost. The following may be taken as a fair efficiency to be aimed at as a first attempt: Iron loss, 150 watts = $2\frac{1}{2}$ per cent. of the total output. Copper loss, 60 watts in each circuit at full load, or a total copper loss of 2 per cent. Transforming ratio, 2,000 volts to 100 at full load. Thus it will be well to make the ratio 2,000 to 102 at no load to equalise the effect of the copper drop. The frequency we will assume to be 100 complete cycles per second. The designs will be taken at random, and will not necessarily be the most economical of the various types. The cost of material may be taken as giving some indication of the probable cost of manufacture. So, assuming the copper to cost 10d. per pound, and the iron 4d., we shall work out in each case the cost and weight per kilowatt output.

(To be continued.)

OBITUARY.

THE LATE EDWARD ALFRED COWPER.

For many years past there has been no figure much more prominent in all gatherings of engineers than that of the late Edward Alfred Cowper, whose death we regret to have to record. He was the son of Edward Cowper, professor in the engineering department at King's College, and known as an improver of the printing-press. The late E. A. Cowper was born December 10, 1819, and he died of pneumonia on May 9 this year, after a short illness. As was customary in those days, at the age of 14 years he was apprenticed to John Braithwaite, and while still an apprentice he invented the ordinary fog-signals for use on railways. The first trial of these signals, now so well known, was made on the Cardiff Railway. During this period also he was working on Captain Ericsson's invention and in railway work. In the year 1846 Mr. Cowper went to Birmingham to the factory of Fox and Henderson, where he invented an improved method of casting railway chairs. The next year he assisted in founding the Institution of Mechanical Engineers, and was on the council from its foundation. He was elected president in the session 1880-1. The following years were full of good work, and in 1851 he was closely connected with, and actually did, most of the contract drawings and the machinery for making the parts for the International Exhibition. While still with Fox and Henderson he designed the roof of the Birmingham Station, New-street, the first large span station roof (211ft. span). In the same year (1851) he started in business for himself as a consulting engineer, which he continued to the time of his death, having recently taken his oldest son, Mr. Chas. E. Cowper, into partnership. Perhaps to engineers Mr. Cowper's name is more closely connected with the hot-blast stove than with anything else. His first patent for this regenerative firebrick stove being taken out, subsequently many other patents were taken out, the latest of which was that of 1887 for having bricks in the form of a honeycomb. Upwards of 500 of these regenerative stoves are now in use. He paid considerable attention to steam-engine economy, and took out patents for compound engines and for marine engines. In 1868, according to the Patent Office records, we find that he invented the modern suspended wheel for bicycles, with hard steel spokes and rubber tyres.

From an electrical engineer's point of view, however, Mr. Cowper's name is associated with the writing telegraph, he having invented an instrument of this description, which in 1879 was shown at the Institution of Electrical Engineers, and at the Royal Society. It is described in most of the technical papers of that date. Mr. Cowper was connected with all the engineering societies, was a member of the Institution of Civil Engineers, and, as we have previously said, of the Mechanical Engineers. He was a member of the Iron and Steel Institute and various other institutions, among which we may mention the Institution of Electrical Engineers. He acted as a juror to various exhibitions, and more than once for the Royal Agricultural Society. In 1884 he was selected to deliver the special lecture on the steam-engine before the Institution of Civil Engineers. In 1887, in conjunction with Dr. Anderson, he made experiments on the modern equivalent of heat, and the paper of his colleague was read before the meeting of the British Association. We have often listened with admiration to the remarks of Mr. Cowper made at meetings, and the last time we had that pleasure was not long since at the Institution of Civil Engineers, when the question of small-arms was under discussion. Whenever Mr. Cowper spoke he was sure to throw considerable light upon the subject in such a manner as to be understood by everyone of the audience. His has been a busy life, and he will long be remembered by his associates as an earnest and successful worker in providing for the multitudinous wants of civilised life.

ON THE PREVENTION AND CONTROL OF SPARKING; CONTINUOUS-CURRENT DYNAMOS WITHOUT WINDING ON THE FIELD MAGNETS, AND CONSTANT-PRESSURE DYNAMOS WITHOUT SERIES WINDING.[*]

BY W. B. SAYERS, ASSOCIATE.

The object of this paper is chiefly to lay before the Institution certain means for bringing under independent control the commutation of ring and drum armatures for continuous currents. The limits dependent on considerations of sparking at the brushes being thereby done away with, a new field of design is opened up.

Mr. Swinburne and Mr. Esson—the former in his paper read before this Institution in 1890, and the latter in his papers in 1890 and 1891—both give expressions for the maximum load which can be carried without sparking; these expressions are in terms of the ampere-turns upon the armature, the length of the air-space, the angle subtended by the polar surfaces of the field magnets, and the forward induction. Thus it is recognised that in ordinary ring and drum armature machines the consideration of sparking fixes, or at least limits in one direction, some of the most important elements in the design of the machine, and is not separately controllable. A practical result from this is that the lightening of machines by putting the conductors in tunnels, reducing the air-space to a mere clearance—which has been proposed from time to time, notably by Mr. Swinburne, and which is the condition in which minimum exciting force is required, and, consequently, the condition of minimum weight of magnets—has not been hitherto practicable.

The conditions of sparkless collection, when no special means are employed for bringing about the reversal of the sections as they pass the diameter of commutation, are now well understood; but as I have found it somewhat difficult to describe the action of the devices which I wish more particularly to bring under consideration, I have prepared four diagrams which I think represent the action fairly well, and which will at least be useful as a stepping-stone towards that which I wish to describe later on.

In diagrams 1 to 8 I have ventured to distinguish the currents flowing from the two halves of the armatures by red and blue colouring[†] beside the wires in which they are flowing. This is merely to enable me to refer briefly to the two halves of the current, and to clearly distinguish them in the diagrams.

Diagrams 1 to 4 represent part of an ordinary ring armature machine spread out flat. Suppose, as is the case usually, the brush makes contact over an angular breadth equal to that of one section of the commutator, or a little more; then the current reaches the brush alternately through one commutator bar, and through two. Figs. 1 and 3 represent diagrammatically these two conditions. In Fig. 1 the commutator bar, C, is represented centrally under the brush. In this position the currents flowing from the two halves of the armature unite in the commutator connection, B, and flow thence through the commutator bar to the brush. As the armature moves onward in the direction indicated by the arrow, the armature coil A is seen to be short-circuited under the brush. The current flowing in it at the moment when it becomes short-circuited would be counter clock-wise, looking from the lower end, but the coil, from its position, is beginning to cut lines of force in a sense tending to induce a clock-wise current. The counter clock-wise current therefore falls, and at the same time a current rises in B^1, such that the current in B, plus the current in A, equals at any moment the half-armature current. Fig. 2 represents the position when the red half is equally divided between B and B^1, B carrying in addition the whole of the blue half. The next stage is shown in Fig. 3, when the current in the armature coil A is passing through zero value. At this instant the blue half of current flows to the brush by B alone, and the red half by B^1 alone. A clock-wise current now commences to rise in A, the current in B falling correspondingly. Fig. 4 shows the position when the blue half is equally divided between B and B^1, while B^1 carries in addition the whole of the red half. As the armature still moves on, the position shown in Fig. 1 is again reached, the current in A having risen, under the influence of the induction, to the value of half the armature current. At the instant when this is so, the current in B^2, Fig. 1 (which we now look upon as B moved through the angular distance of one section), is necessarily zero, and if the tip of the brush breaks connection with the commutator at this instant the break will be sparkless.

Several devices have from time to time been proposed for controlling sparking at the brushes of dynamo machines—notably the use of reversing pole-pieces. Mr. Hookham, of Birmingham, told me—I think in 1889—that he had succeeded in obviating the necessity of moving the brushes for varying loads by their means. Mr. Swinburne has also advocated the use of reversing pole-pieces, and Mr. Edison has from time to time since 1883 patented various arrangements with the object of introducing a counter E.M.F. into the short-circuited coil, with the object of avoiding sparking and the necessity for moving the brushes with varying loads.

Still, there would appear to be in the minds of some a vague idea that sparking is due generally to an abnormal current being generated in the coil which is short-circuited under the brush. That is far from being true as a general rule, as appears from the actions I have described. An excessive current can only be reached in the short-circuited coil after the requisite reversal has taken place. Take Fig. 1. If the brush does not break at the instant here depicted, the current in the armature coil A^2 will rise above the value of half-armature current, a back current being started in B^2 which flows round through A^2 and B to the brush, and may be considered as superimposed upon the half-armature current in A^2 and B; when the break occurs, there will therefore be a spark, which, it may be noted, will tend to maintain itself as an arc across the insulation between C and C^2. This excess current in A^2 and B, then, only occurs after the reversal of the section has been duly accomplished—that is, when the reversing of the section has been carried too far. Now moving the brushes back so that the coil is short-circuited in a slightly weaker field would at once correct this fault. We must, therefore, conclude that if with a given load there is no sparkless position for the brushes of a machine, it is because the coil which has been short-circuited under the brush comes mechanically into the circuit with too little or no current in it, or, in a very bad case, even with the current still in the wrong direction; in other words, the reversal has only been partially effected, or not effected at all, by the inductive action of the field. If in an ordinary machine (speaking of generators) the brushes are shifted backwards so that the armature coils are short-circuited while cutting lines of force of such direction as not to tend to reverse the current in them at all, but rather to increase it, the reversal is only accomplished by the mechanical make-and-break action of the brushes and commutator sections, and is consequently accompanied with violent sparking. I think it is abundantly clear, then, that excess of current in the coil which is commutated is never in practical work the cause of sparking, but that, on the other hand, sparking which cannot be got rid of by shifting the brushes forward is due to the current of the coil being too small when the break occurs between the commutator section and the brush.

It is still the practice with some makers to use driving pins at intervals, causing a greater angular space between some of the armature sections than the normal, and the consequence is that the brushes cannot be in the correct position for all the armature coils at the same time. Such machines will invariably be found to be marked at the commutator in a manner regularly increasing and decreasing in relation to the position of the driving pins: the marking will be more or less distinct according to the nearness to the same position in which the brushes are set from time to time for the same loads; because, if in such machines the brush is shifted through a small angle, the sparking is transferred from some sections to others, so that if the brushes are moved about sufficiently the sections will all get marked alike. When the pins are necessary there seems to me to be a very simple remedy for the defect under consideration. I suggested this remedy to Mr. Crompton about 18 months ago, but I do not know whether he has made any experiments with it. The remedy is to make the divisions in the commutator to correspond with the divisions of the armature sections. Thus, in the position corresponding to the position of a driving pin there will be a commutator bar having an angular width equal to the normal width of a section, plus the angular width occupied by the driving pin. For good appearance the width of pin might be equal to the angular width of the commutator section, and a dummy section connected to one of its neighbours put in the commutator at the position corresponding to the position of the driving pin.

Before describing the special means by which I secure the sparkless reversal of the section under the brush at any desired place between the horns of the pole-pieces, I may briefly state the characteristic features of the new machines which the use of the devices referred to has enabled me to design. These are as follows: The air-space is a mere clearance—one millimetre. The reversal of the sections is effected by inductors, or coils, which I have called "commutator coils," independent of the main winding; these commutator coils are so arranged as to be acted on by the pole-tip which is strengthened by the armature current, and the brushes of the machines when run as generators are set with a backward lead instead of a forward one. The commutator coils enabling me to reverse the armature sections just after they have emerged from under the strengthened pole, the result is that what have hitherto been called back turns of the armature winding become forward turns, and the effect of the cross-induction is to increase the reversing field instead of to diminish it, and the manner in which they operate in producing it.

The machine illustrated in diagram 9 has all of these features. It is self-exciting by means of the armature winding only—that is, it generates a current, behaving like a series machine, of course without any winding at all upon the magnets, which may therefore more properly be called keepers; and it runs absolutely without spark at the brushes.

Before further describing this particular machine, I will describe as clearly as I can the means which I adopt for obtaining these results.

Figs. 5 to 8 represent diagrammatically a ring armature machine wound with "commutator coils" for causing the reversal of the armature sections close against the horn which is strengthened by the armature reaction. The commutator coils consist of coils wound round the armature core, and each connected at one end to the main winding at points between the sections, and at the other end to the commutator segments. There are thus as many commutator coils as there are sections in the armature. The commutator coils are placed at an angular distance from the sections of the winding between which they are connected, being from one to two sections nearer the pole horn which is strengthened by the armature current. The direction of winding of the commutator coils relatively to the main winding is such that if the winding is followed around the core from a point in the main winding under the "flux" horn—which I have ventured to name the horn which is strengthened by the armature current—in the direction which leads out from under the tip of the horn to a point where a commutator coil branches off, and the commutator coil is then followed, the wire leading to, and forming, the commutator coil doubles back under the flux horn, and is then wound around the core in the same direction as that followed when tracing the main winding. This will be seen clearly on referring to Fig. 5. Starting from the point E and following the main winding down to the point D, then passing up commutator coil, B, it will be seen to pass around the core in the same direction as the main winding.

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[*] Paper read before the Institution of Electrical Engineers.

[†] In the blocks — — — stands for red colouring and —. —. — stands for blue colouring.

Figs. 5, 6, 7, and 8 represent four stages in the commutation of an armature by means of my commutator coils, corresponding to the four stages represented in respect of ordinary winding in Figs. 1, 2, 3, and 4.

In the following description it will be seen that the actions depend essentially upon the difference of pressure induced in the two or more commutator coils concerned at any time, and it follows that the angular distance between the coils must be considerably greater than the length of the air-space, otherwise the difference between the E.M.F. generated in the two bars may be insufficient. This necessity, of course fits admirably with the conditions in short air-space machines. I have, indeed, made no experiments up to the present with the device on smooth-core armatures, but when used on such machines I think it would be necessary to reduce the number of sections in the armature to less than the usual practice, so as to get a sufficient distance between the two commutator coils or bars to produce the required preponderance of pressure in one of the two or more segments under the brush.

Fig. 5 illustrates the approximate conditions when one commutator plate is central under the brush. The red half of the armature current meets the blue half at the point D, whence the whole current passes by the commutator coil B to the brush; and it will be noted that as the coil B is just under the tip of the pole horn, the E.M.F. due to one turn is generated in it, and is added to that generated in the main winding. This being the case at the other brush also, the effect of the commutator coils in increasing the E.M.F. is equal to that produced by four of the main conductors on the periphery of the armature. Fig. 6 represents the *armature a quarter section* further on than Fig. 5. The commutator coil B having moved away from the pole-tip, and consequently into a weaker field, has less E.M.F. generated in it; there is also a fall of potential throughout its length due to the resistance of the conductor. The commutator coil B^1, however, which is now in contact with the brush, is still under the pole, and B and B^1 are united at their inner ends by the main winding, section A. Now, the main winding, section A, although yet a considerable distance from the neutral zone, is cutting few lines of force compared with a coil under the flux horn. Under these conditions, then, the current which was flowing in B is transferred to B^1 under the action of the resultant E.M.F. in the circuit composed of armature coil A and commutator coils B and B^1, completed by the brush.

Fig. 6 shows the instantaneous condition a quarter section further on than that shown in Fig. 5, half the red half of armature current flowing through B^1, the other half flowing through the armature coil A and joining the blue half at D, and thence through B to the commutator.

Fig. 7 shows the point half a section from the starting point, depicted in Fig. 5, where the current in the armature, section A, is at zero value, the red half of armature current flowing out by B^1, and the blue half by B.

Fig 1.

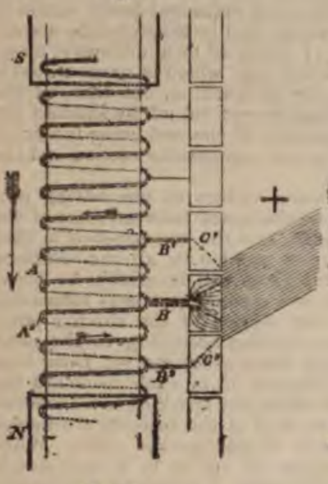


Fig 2.

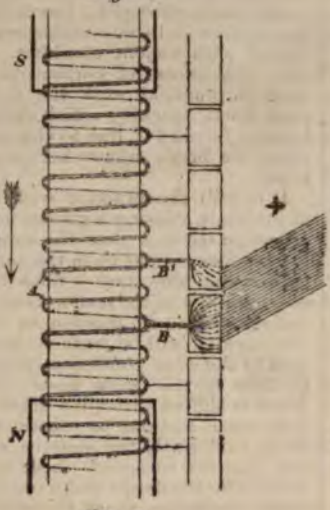


Fig 3.

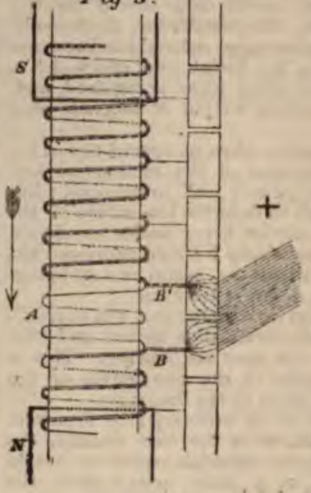


Fig 4.

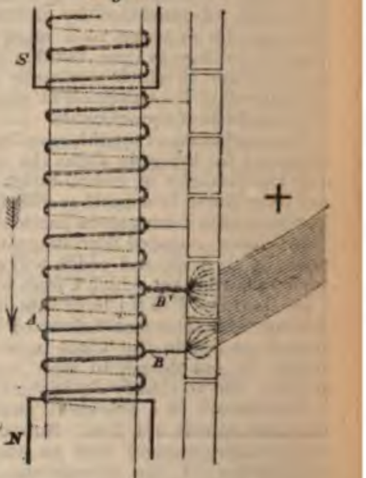


Fig 5.

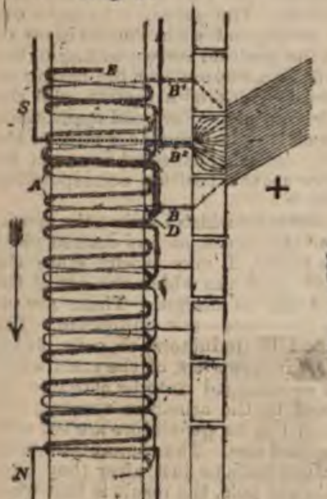


Fig 6.

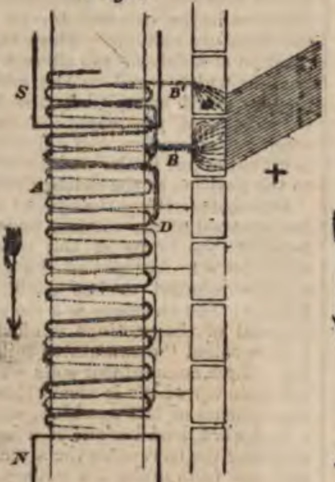


Fig 7

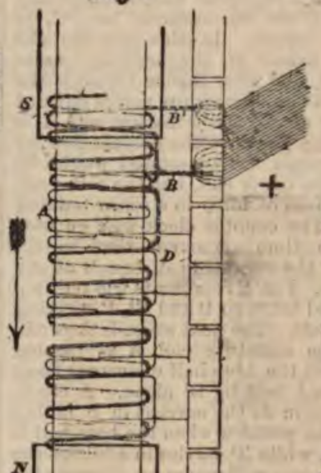


Fig 8.

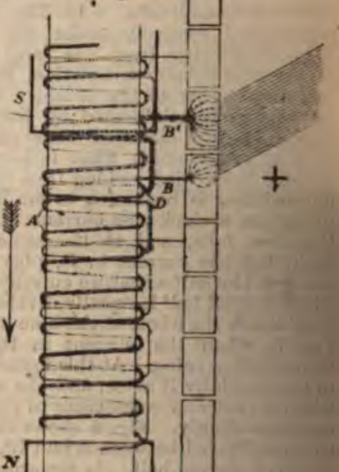


Fig. 8 shows a point three-quarters of a section from the starting position, when half the blue half is still flowing to the brush via B, while the other half has commenced to flow around A (thus starting the current in the required direction in A); arriving at the point D, it joins the red half and flows through B^1 to the brush. Fig. 5 may be regarded as the next stage, the armature having moved through an angular distance equal to one section; the current in B^2 (which we regard as B moved one section on) is almost extinct, A is carrying nearly the normal = half-armature current, and by the time the commutator segment breaks with the tip of the brush the current flowing from it will be zero, and the break consequently sparkless.

Proceeding now to consider practical applications of my device, Fig. 9 represents diagrammatically the first machine made self-exciting by means of the armature winding alone. The machine is now running at the Bradford Station Hotel, Midland Railway, as a regulator. It is coupled direct to a shunt motor, and driven at constant speed. The main current to the hotel is passed through the armature, causing an induction proportional to itself, and thus raising the pressure in proportion to the current flowing, and compensating for the drop in the leads, just as a series machine would do under the same conditions.

articulars and dimensions of the machine are as follows :

Armature—Ring form.

Diameter, external	9⅝in.
,, internal	4¼in.
Length	9in.

periphery has 40 slots cut into it in which the conductors placed. The slots are ¾in. deep, ¼in. wide, and each has two oves cut in it opposite to each other near the top. The main ding conductor is of copper strip 0·15in. × 0·5in., and occupies space in the slot below the grooves. The commutator coils ars are of copper, 0·1in. × 0·3in., with rounded edges, insulated .C., then double-lap tape. They are slid into the slot from end, their edges fitting into the two grooves. Thus they serve old the conductors in position, and so obviate the necessity for ling. The air-space is one millimetre.

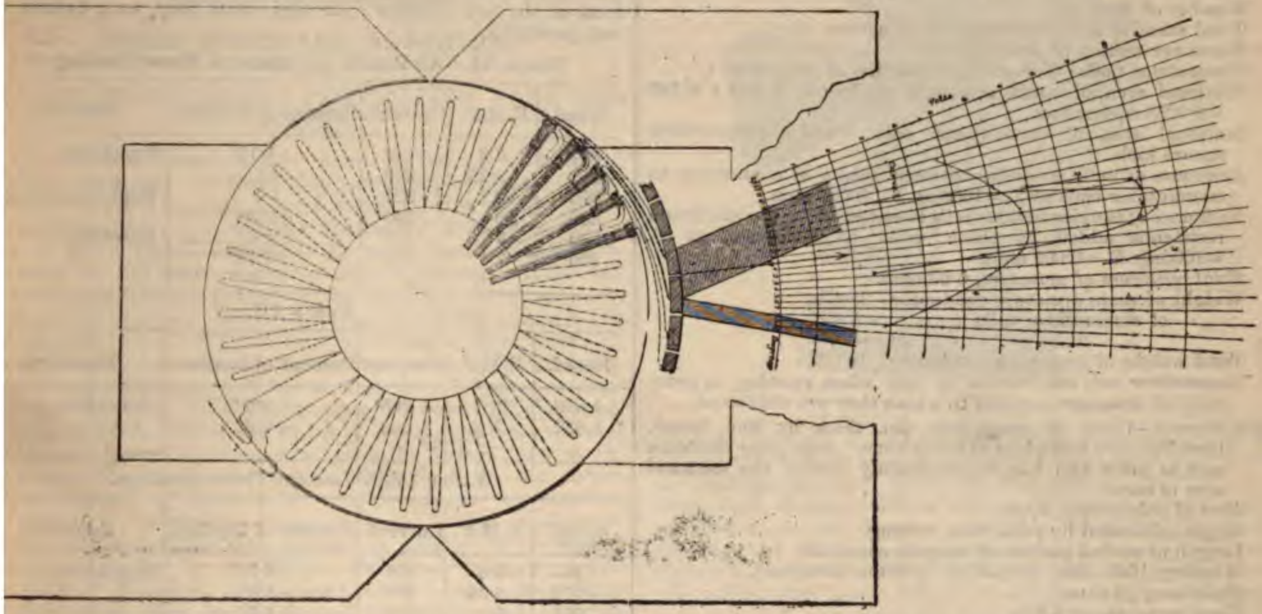
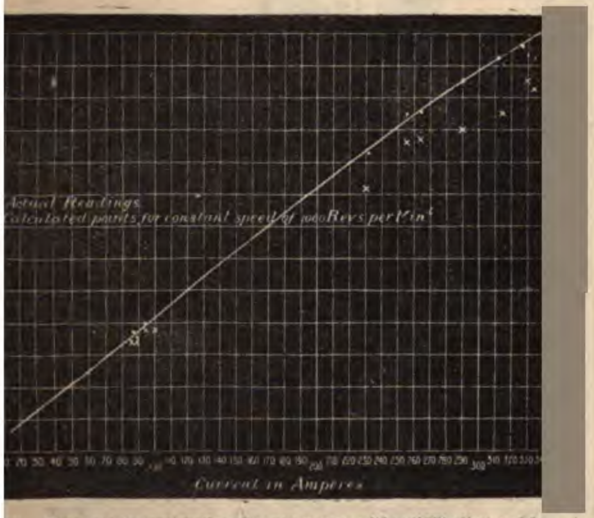


Fig. 9.

ie keepers (they really are not field magnets) are of double ape, and made up of charcoal iron plates to prevent heating the variation of the flux over the polar surface caused by the in the armature. The keepers are separated in the centre in r to reduce the cross-induction, which is of course very con-able.

iave had in mind trying Prof. S. P. Thompson's suggestion of ing the keepers (F.M.'s) up of separate plates, with the object ducing cross-induction. In subsequent machines the necessity



10.—Characteristic of Self-exciting Dynamo without Winding on Magnets.

aminating the polar surfaces has been obviated by putting the uctors into tunnels, and only running a saw-drift through the n of the tunnel to break the iron circuit and reduce the self-ction of the section ; the well-known device of winding over charcoal iron wire has also been used.

n testing the machine illustrated in Fig. 9, it was found, as I ected, to be self-exciting, and it will carry a current of 400 eres at 14 volts running at 900 revolutions per minute. It is ble of running with this current absolutely without spark at brushes. There is hardly any external field—sufficient, of se, to move a compass, but hardly enough to feel with a piece on—except between the two keepers in the space marked F, re there was considerable field, due, of course, to cross-ction.

According to Mr. Esson's formula, the output should be $(20{\cdot}5)^2 \times 22{\cdot}5 \times 15 \times 0{\cdot}048 = 7{,}000$ watts. The comparatively small output obtained—5,600 watts—is accounted for by the fact that for the purpose for which it was designed (to act as a regulator) it was necessary to keep the induction density in the iron below 10,000 in order that the E.M.F. should be as nearly as possible proportional to the current.

Fig. 10 is the characteristic curve of the machine—the horizontal distances representing the current, the vertical distances the volts.

The most remarkable feature observed about the machine when self-exciting is its extreme sensitiveness with regard to the position of the brushes, a very small movement causing a great variation in the volts. Moreover, it will not excite at all unless the brushes are within a certain arc of about 9deg ; the position of this arc corresponding with the position in which the hindermost commutator bar under the brush is under the pole-tip, and the foremost one has passed out from under it.

The curves to the right of the brush in Fig. 9 represent the volts observed with the brushes in various positions. The pointer drawn through the brush indicates the point in the curve corresponding with the brushes in the position shown. Thus, if the brush and pointer were shifted in either direction, the pointer would indicate the volts corresponding with the position of the brush.

Curve No. 1 is plotted from results obtained when the machine was running at a speed of 850 revolutions per minute, and an external resistance in circuit of about 0·03 ohm, the maximum current reached being about 340 amperes. For curve 2 the speed was 1,000 revolutions per minute ; external resistance, 0·038 ohm ; and maximum current, 291 amperes. Curve 3 shows the effect of one turn of series winding around each keeper, with speed 1,000 ; external resistance, 0·0455 ohm ; current, 202-265 amperes. Curve 4 shows the effect of moving the brushes when a constant current is passed through the armature : speed, 1,000 ; current, 200 amperes. These curves are plotted from the Tables I., II., III., IV. given below.

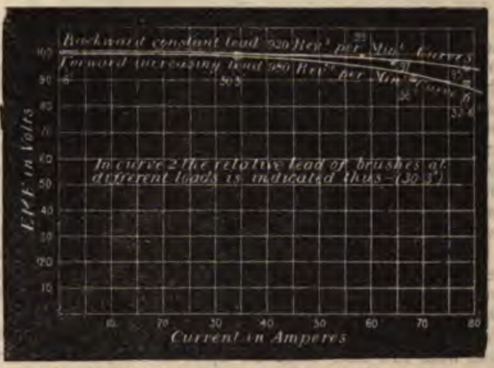


Fig. 11.—Machine No. 308. Test made March, 1893.

It will at once be obvious to all that a shunt machine with armature on my principle may be made to keep pressure constant with varying current, part of the armature winding performing the function hitherto performed by the use of series coils on the magnets. As would be expected, the armature coils so used are several times more effective, turn for turn, than an equal number of series coils upon the magnets. First, they count double, because they would exist as back turns if the machines were running with a forward lead ; and, second, because, whereas in the latter case the effect of the series coils—or, rather, of the remainder of them after subtracting the number of the back turns—depends upon the permeability of the field magnets and armature, and all magnetic leakage is, of course, ineffective, the action of the forward turns on the armature when running with a backward lead, though depending on permeability of the armature core and magnets, is wholly effective, even the leakage (if we so call the lines which do not pass around the magnet cores) being necessarily cut by the conductors on the armature.

The particulars of such a machine are as follows:

Particulars of Nine-Unit Shunt-wound Dynamo; 100 Volts, at 920 Revolutions per Minute.

Armature—Diameter at bottom of slot, $6\frac{7}{8}$in.
" of hole in centre of discs, 2in.
" over all, 9in.
Length of iron core, 10in,
Dimensions of slots, $1\frac{1}{16}$in. deep by $\frac{1}{4}$in. wide.
Number of slots, 40.
Total turns of main conductor on armature, 80.
Turns per section of armature, 2.
Commutator Coils: Turns to each section of armature, 1.
Sectional area of main armature conductor, 0·180 × 0·160 = 0·0288 square inch.
Sectional area of commutator coils, 0·180 × 0·08 = 0·0144 square inch.
Resistance of main conductor between points of connection to commutator coils at T. = 100deg. F., 0·025 ohm.
Resistance of two commutator coils in series, being the maximum resistance added by these coils to armature, at T. = 100deg. F. = 0·005 ohm.
Total resistance of armature, 0·03 ohm.
Weight of main armature conductor 35·4lb.
" of commutator coils............ 8·8lb.
Total weight of armature conductor 44·2lb.
Commutator coils one section in rear when running as generator of armature sections to which they are connected.

Field Magnets—Cores of scrap iron, 6in. thick by 10in. broad. Cast 3in. into sole-plate at lower ends. Sole-plate therefore acts as yoke, and has approximately double the sectional area of cores.
Bore of pole-pieces, $9\frac{7}{16}$in.
Angle subtended by polar face, 130deg.
Length of wound portion of magnet cores, 8in.
Winding, 120lb. No. 18 S.W.G. (0·048in. diameter).
Resistance, 70 ohms.
Total turns, about 5,120.
Ampere-turns in shunt winding, 7,300.
Current through shunt coils, 1·43 amperes.

From the foregoing we get the following in C.G.S. units:

Armature—Effective area of core, allowing for 5 per cent. occupied by paper, 297 square centimetres.
Total induction through armature core, 4,000,000.
Density, I = 13,400.

Field Magnets—Total induction through magnets, assuming leakage coefficient of 1·2, = 4,800,000.
Density, wrought iron, I = 12,400.
" cast iron, I = 6,200.
" air-space, about I = 6,700.
Magnetising force required:
Air-space (2 l. = approx. 1 cm.) = 5,350 ampere-turns.
Armature core .... 320 "
Magnet cores.............................. 828 "
" yoke .... 642 "
Total .... 7,140 "

This machine was not originally designed to be self-regulating when running with a backward lead, and consequently the width between the magnet cores only allows of an angular breadth embracing two and a-half to three sections of the armature to assist the forward induction. In Fig. 10, curves 1 and 2 show the performance of the machine as a generator when run with backward and forward lead. With backward lead the position of brushes remains unchanged with all loads. The E.M F. on open circuit is 100·5 volts at 920 revolutions per minute, at full load 95 volts. Thus, allowing three volts for drop in armature and brush connections, the E.M.F. generated at constant speed of 920 revolutions per minute is 2·5 volts less with full load than on open circuit. With forward lead the E.M.F. is 100 volts on open circuit at a speed of 980 revolutions per minute, and 88·8 volts at full load. Allowing three volts for drop, as before, the E.M.F. generated is 8·2 volts less with full load than on open circuit, and the brushes require shifting through a total angle of about 35deg. between no load and full load.

Tables V. and VI. give the readings from which the curves 5 and 6, Fig. 11, are plotted. In the experiment the E.M.F. was kept as near as possible constant, the results with constant speed being calculated therefrom. Run with a forward lead the machine displays the drop inevitable with a rather short air-space.

I think I am perhaps entitled to say that all the machines I have made have been made to fill orders, which they have successfully done. So far, my experience has been that the shorter the air-space the better as regards sparking and fixity of the collecting position. If solid magnet cores are used, as they must usually be on account of the expense of laminated cores, the length of the air-space is limited by the width of the slots. In this connection I have found that the slots may be 1·5 times the length *of air-space* without any appreciable heating of the poles or waste of power from eddy current in them. If the armature is wound over with iron wire of sufficient thickness compared with width of slot, or if the conductors are in tunnels, the length of the air-space can be fixed, having regard to mechanical considerations only. In this connection, however, it is necessary to take into consideration the unequal pull of the keepers, or magnets, if the

TABLE I.

Speed.	E.M.F.	Current.	Position of brushes*	Remarks.
1,062	0·83	—	+2·93°	—
1,058	3·27	89	0	Sparkless.
1,065	3·63	105	0	"
1,019	11·2	291	0	Slight sparking.
1,035	10·23	260	+0·6°	" "
1,055	4·68	175	−2·34°	Sparkless.
1,062	2·83	78·14	−3·8°	"
1,007	9·28	242	+2·93°	Slight sparking.
1,059	3·53	92·5	+4·4°	Sparkless.
1,045	3·53	92·5	+4·4°	"

* The zero position of brushes is indicated in the diagram Fig. 9. The sign + in front of the figures indicates that the brushes were in front of the zero position; the sign − that they were behind the zero position.

TABLE II.—All Results are Means of Three Readings.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
847	5·6	189	+1·15°	Sparkless.
850	8·35	289	0	"
850	9·9	321	—	Slight sparking.
850	10	340	+2·3°	" "
850	9·76	326	+4·6°	Sparking.
850	7·1	237	+5·75°	—

TABLE III.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
1,016	12·1	265	+0·6°	Sparkless.
1,032	9·2	202	+0·6°	"

TABLE IV.—Means of Three Readings.

Speed.	E.M.F.	Current.	Position of brushes.	Remarks.
988	5·8	198	+2·93°	Sparkless.
972	6·35	200	+4·4°	"
991	6·1	200	+4·4°	"
996	5·66	199	+6·72°	Slight sparking.
1,005	4·6	199	+8·8°	More sparking.
1,013	2·92	194	+11·7°	Slight sparking.
984	6·7	204	+2·93°	Sparkless.
991	6·78	207	0	Slight sparking.
994	6·1	206	−2·93°	More sparking.
1,002	5·21	204	−5·85°	Sparking under brushe
988	4·86	205	−7°*	Slightly more.

* If moved farther back, serious sparking occurs, so that carbon brush gets red hot.

TABLE V.

Speed.	E.M.F.	Current.	Brush displacement relative to position at no load.
918	101	0	0
920	100	0	—
928	101	34	—
942	103	35	—
906	100	58	—
916	100	58	—
940	100	67	—
966	101	62	—
964	100	80	—
964	99	78	—

TABLE VI.

Speed.	E.M.F.	Current.	Brush displacement relative to position with backward lead.
978	97	0	6·6°
940	98	0	6·6°
1,002	100	35	30·3°
990	102	34	30·3°
1,120	100	72	36·0°
1,120	108	65	36·6°
1,078	98	78	32·6°
1,116	100	79	32·6°

armature is a little out of centre; for, unless the shaft is very stiff, this may be sufficient to cause the armature to touch against the keeper when excited.

My machines, made by Messrs. Mavor and Coulson, of Glasgow, of course, run with a forward lead as motors, the forward armature turns still increasing the induction.

I have perhaps hardly laid sufficient emphasis upon the fact that increase in the armature current increases the strength of the flux horn, and so tends to automatically bring about the sparkless reversal of the sections without any shifting of the brushes.

I think it will be abundantly clear that, so far from having fully described what may be done by means of my device for bringing the commutation of ring and drum armatures under independent control, I have only touched on the border of a new field of design for continuous-current machines.

TRADE NOTES AND NOVELTIES.

ALTERNATING-CURRENT VENTILATING FANS AND MOTORS.

The summer season is now upon us, looking as if it had come to stay, and we learn that ventilating engineers in consequence thereof are full of work fitting up City offices, banks, restaurants, etc., with electric ventilating appliances, every one of which installed, it must be remembered, will tend to increase the day load. Central-station managers will do well to encourage this new branch of the industry, which not only adds comfort to their customers during this sultry weather, but brings grist to the mill for current consumed to drive them. A great difficulty has hitherto been experienced in getting a fan-motor appliance to successfully work on the alternating-current circuits. However, this difficulty appears to have been overcome, judging from the numerous types of small alternating-current motors one sees exhibited and at work in various parts of the City and West-end — facts which Mr. Snell in his recent paper appears to have quite overlooked, as no mention is made or description given of these useful appliances. Probably amongst the most popular at present in the market are those supplied by the Edison and Swan Company, which are of the "Windmill" and "New Cyclone" types, the working of which draw large crowds around the windows of the company's stores in Cannon-street, when these useful little appliances are in action. These, we learn, are being supplied in ⅛ h.p., ¼ h.p., and ½ h.p. sizes, suitable for driving the Blackman, the Wing, Britannia, Sturtevant, and many other well-known types of blowers and air propellers. Another candidate seeking for popular favour is the small "Meston" ventilating complete fan set, which appliance is being introduced into the country by Messrs. Shippey Bros., the European agents of the Emerson Electric Manufacturing Company, owners of the Meston system. We give three illustrations of this useful appliance, showing its style and construction. Fig. 1 is a front view of the ventilator, and Fig. 2 back view of same, which is fitted on to a solid tripod stand, having rubber cushions sunk into the feet, which give a secure footing and also prevents the usual vibration of the fans, which are fitted direct upon the spindle of the armature; they revolve at very great speed when working at full pressure, and are nearly noiseless, which is a great point in their favour. Fig. 3 is a special combination, suitable for billiard saloons and restaurants, fitted with a wire guard shield to prevent accidents, or the meddlesome acts of inquisitive people. We may say the novel feature of the Meston motor is that it has no wire at all on the armature, and this little motor being of the self-regulating type, with carbon revolving brushes, the inventor claims that it is impossible to have any burn-outs of same from overwork, or an accidental short circuit. We may say several patents are pending for the Meston system, hence we are unable to do more at present in the way of description. The motor is self-starting and reversible, and has self-oiling bearings. It is also made in two windings for working at either high or slow speeds, and we are told that it can be regulated to run at any speeds according to requirements and periodicities of the circuits.

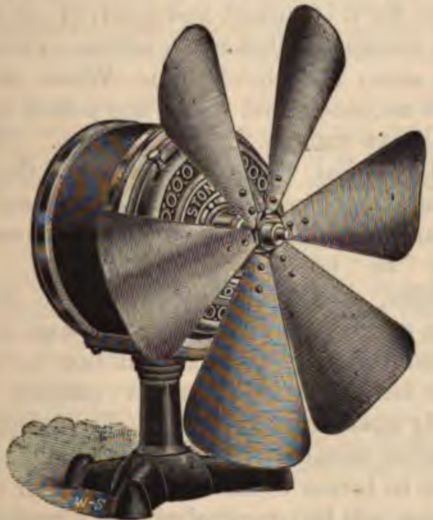


FIG. 1.

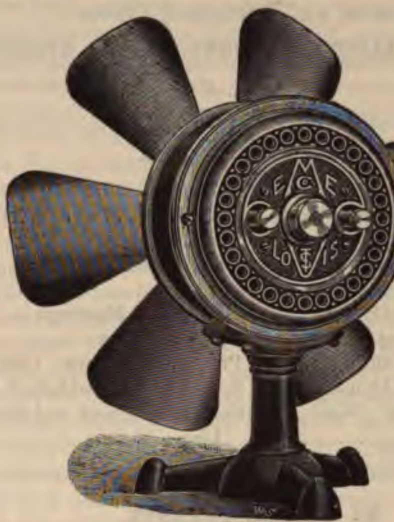


FIG. 2.

A large number of the Meston motors have been sold and are already working sewing-machines, dental drills, hair-brushing machinery, small hotel pumps, lathes, Blackman fans, Sturtevant blowers, dinner lifts, and various other domestic appliances on the London, Brighton, Sheffield, Newcastle, Dublin, and Parisian alternating-current circuits with satisfactory results. We cannot but think that the supply houses who exhibit these goods would be wise to announce (by some sort of tablet or notice) the fact that they are adapted for alternating currents, especially as the general public have so long been led to believe that alternating-current motors suited to the above requirements were unobtainable, and if the day load is to be made a source of profit to central stations the more publicity is given to these facts the better it will be for all concerned. Probably the reason why Mr. Snell omitted to allude to these modern types of motors was the absence of a little more publicity being given to the facts, for even a slight allusion to them would have enhanced the value of his paper by recording authentic information of the work going on up to date. Dr. Fleming recently exhibited one at the Society of Arts, which greatly interested the members present. Another type of Meston motor is now upon the market, specially designed to work at slow speeds of 200 to 280 revolutions per minute, suitable for working all kinds of small machinery and appliances for domestic power purposes. They are furnished with a regulator and brake, arranged for connection with a foot-treadle, by which the speed can be changed at will; and the motor being reversible and of the self-starting and self-regulating type, it can be run in either direction.

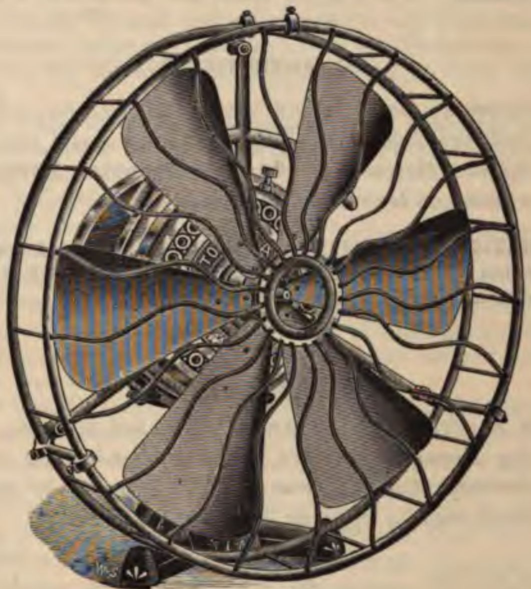


FIG. 3.

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"**Magnetic Viscosity**"—*A paper by Dr. Hopkinson, F.R.S., E. Wilson, and F. Lydall, read before the Royal Society, with several other articles and communications, are held over till our next issue.*

TRACTION v. TELEPHONY.

We have no reluctance in once more discussing the relation between electric traction and telephony. The latter has done its level best to render the former impossible. It may be that bad telephony is of more importance to the community than electric traction, but with this view we must differ. However, as will be seen from the letter signed by Messrs. R. E. Crompton, E. Garcke, and Sidney Morse, the old foes have once more crossed swords, and are about to settle matters once for all before a Joint Committee of the Lords and Commons. We think these gentlemen have stated the circumstances of the case very fairly, and, from the traction point of view, very mildly. Telephony acts as if it desired to conserve a bad system, and monopolise the earth as a return to its sole use. This we cannot submit to, nor till the Legislature finally settles the matter shall we refrain from attacking this position. We would ask the Municipal Engineers, who have a meeting at Derby to-morrow, to consider the problem and to assist in straightening it out. An official recognition by that representative body that telephony to be perfect ought to be on the complete metallic circuit system, and that the use of the earth is of more service generally when traction is in question than for telephony, would have more weight with this Joint Committee than all the arguments of paid advocates and interested parties. No doubt telephony can subsidise a score of eminent men to give evidence in its favour—so can traction; but what is the value of the evidence? A case can be made either way. Expert evidence paid for by either party simply means that the expert sees for the moment the side he is paid to see, and ignores the other side of the shield. Cross-examination cannot shake his evidence, for it is correct and good so far as it goes. Nobody denies but that earth return in telephony is cheaper than metallic return. What we deny is that it is as good; and what the public wants, and what it pays enough for, is the best. The expert will tell you that *if* this is done, and that is done, and this precaution taken, then articulation even with earth return is clear and distinct, leaving nothing to be desired. Experts, however, may differ, and yet be right. The *if* will be found to cover a multitude of sins, and in practice be found wanting. We should not be surprised, then, to hear the Government officials speaking decisively against earth returns for telephony, and in favour of metallic returns. We assume that the evidence in favour of metallic returns for excellence of service will be overwhelming. Every municipal authority is bound to do its best in the interests of its constituents. Telephony assists business; then favour telephony, but favour it in its best form—that is, with metallic returns. It is possible many will argue that means of quick movement from point to point facilitates business even more than quick communication. Say it is equally important. Here, again, we want the best system, and the question arises whether the use of earth is as bad for traction work as it is for telephonic. The consensus of opinion is that not only is it not bad, but it is impossible in most cases to avoid leakage to earth, so that repression of its use means death to electric traction wherever telephony is in a position to say "No." Horse traction has been under trial for years. No one with a spark of love for horseflesh—which some of us put next to human flesh—can say a word in favour of horse traction, but hitherto cost has kept it to the front. Steam, cable, and electric traction have been tried. Go where steam traction is prevalent and it is not liked. Neither cable nor electric traction have made great strides in England, but the former is initially costly, and we think its sphere limited. From long consideration of the subject we believe that electric traction possesses many advantages, and must ultimately take front rank. Roughly, it is of three kinds. Self-contained cars, with accumulators, where the question of earth return ariseth not. Then we have the overhead and the underground systems, wherein earth is in question, and, as it has been said, cannot be avoided. Municipalities must take one side or the other if they do their duty, and we ask them to support the efforts of those who contend that it is against public interest to give telephony the power to prevent the due development of electric traction.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONY.

SIR,—I have read with interest the letters and articles which have appeared in the electrical papers on the subject of telephone systems. I think it is a pity that so much time and energy on both sides should be wasted in trying either to give me or to withdraw from me the credit of novelty in the invention of a system which has hitherto borne my name and which was advertised by the National Telephone Company, Limited, under my name years after I severed my connection with the company. It is a matter of indifference to me who gets the credit, and the only object which prompts me to come out of my shell again is to assist in any little way that may be in my power to bring about what has always seemed to me practicable—viz., a quick and reliable system of switching in large towns.

The object I had in view when I founded the system—which, to avoid controversy, I will call the Dundee system—was to facilitate switching operations. I had observed that the difficulty and delay in telephoning was caused *wholly* and *solely* by the operator having to spend too much time attending to each individual call, and I saw that however ingenious the operating-board, however efficient the system, unless this time given to each individual call was greatly reduced there would be little or no improvement, and the occasional long waits for the subscriber would still occur.

Few telephonists have yet realised that this is really the crux of the whole question, and that this is the point which the Dundee system alone practically grasps. I say practically in contra-distinction to theoretically, because the *Electrical Review* tells me that Shaw first conceived this idea, though it is well known to telephonists that he never put it into practice.

Let me illustrate clearly my meaning. Under any other system it takes the operator at the switching-table from 30 to 60 seconds to complete one connection. If, then, five subscribers ring up simultaneously (an event which occurs frequently), it follows that the subscriber who is attended to last has to wait from two and a half to five minutes, a space of time which every telephone user will admit tries his patience sorely. I know of no more pitiful spectacle than a business man shouting "Hello! hello! hello!" with a phone to his ear, his nose in the transmitter, his thumb on the push-button, and going through the various manœuvres whilst five long minutes roll by.

Unfortunately for the advance of telephony, this difficulty is only experienced by the general public. It is an unwritten law in every telephone exchange that directors and troublesome subscribers shall be attended to immediately their indicator falls, and woe betide the luckless operator who keeps them waiting.

In the Dundee system the operator has only one motion to go through, and the connection is made in from two to five seconds, so that, taking the same instance, if five people ask for connections simultaneously, the last served has only to wait from 10 to 25 seconds.

I am glad to see that the National Telephone Company are about to adopt this system in Glasgow, but I am looking for the day when they will adopt it in London, for it is in large centres like London where it is specially applicable. If it is carried out thoroughly, and the circuit-line system extended over the trunk wires between the exchanges, so that every operator in London is in speaking communication without the necessity of ringing bells or dropping indicators, the telephone service there will be almost instantaneous. I think I may say without fear of contradiction that there are many hundreds of firms in London whose sole reason for not being subscribers to the telephone is that the service is so bad, and that it is often simpler and quicker to send a boy with a message or to use the telegraph.

Verb. sap. Call the system any name you feel inclined to, but adopt it.—Yours, etc., J. J. MANN.

Peel Mills, Manchester, May 16, 1893.

[We agree with our contemporary that this discussion has lasted long enough, but Mr. Mann is entitled to be heard, and we therefore have no hesitation in giving room for his letter.—ED. *E. E.*]

CHEAP TRACTION OR DEFECTIVE TELEPHONES.

SIR,—On 26th April, 1893, a meeting was held at the Board of Trade, Sir Courtenay Boyle, K.C.B., in the chair (Sir Joseph Warner, counsel to the Lord Chairman of Committees, being present), at which the Telephone Company and the Electrical Traction Association were represented.

The Telephone Company put it to the Board of Trade that inasmuch as during the past four years they had opposed some 50 Bills in Parliament, with the result that, with one or two unimportant exceptions, clauses for their protection had been invariably given either in the form adopted in 1889 in the Lea Bridge case or in 1890 in the Plymouth case, the time had now arrived when the Board of Trade should accept one of these clauses as a model clause, and take measures to ensure the insertion of such clauses in all electrical traction Bills and Orders without further action on the part of the Telephone Company.

The essential portion of the Plymouth and Lea Bridge clauses is the first paragraph, as follows: "1. The company shall so construct their electric circuits and other works of all descriptions, and shall so work their tramway in all respects as to prevent any injurious interference by induction or otherwise with the electric circuits from to time used or intended to be used by the Telephone Company for the purpose of telephonic communication or with the currents in such circuits. Provided that as regards electric circuits erected or laid down by the Telephone Company after the construction of the works of the company, this sub-section shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such circuits and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the company."

Sir Courtenay Boyle having heard the representatives of the Traction Association, intimated that the Board of Trade were of opinion that what had taken place *did not* amount to the establishment of an uniform principle that there should be protective clauses in favour of the Telephone Company. He thought that since 1889 a good deal of knowledge had been gained, and that the Board of Trade would now communicate with the authorities of Parliament to see whether the matter could be considered and settled, and that in the meantime the Board of Trade would not insert any protection clauses in favour of the Telephone Company.

As an outcome of these communications a resolution for the appointment of a Joint Committee of Lords and Commons has been passed by Parliament, "to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return circuits, or by any provisions as to leakage, induction, or similar matters, and if so, in what cases and under what conditions. And if the Joint Committee are of opinion that any such prohibition, restriction, or provision should be enforced, to settle the necessary clauses."

The question for consideration by the Joint Committee is, in effect, whether the Telephone Company is to have *its present system* protected or not.

The form of reference does not at first seem to mean this, but it must be borne in mind that the Telephone Company are at present carrying on their business without statutory authority, and that (save by a general Act) Parliament can only legislate by the insertion of clauses into Bills or Orders brought before them by promoters asking for powers to use electric traction.

When this Joint Committee meets it is assumed that the whole question of electrical traction and telephones will be considered, and the committee will either give the Telephone Company the protection for which they ask, or say that any protection shall be conditional upon the Telephone Company amending or altering its system by the introduction of a metallic return or otherwise.

The Telephone Company allege that they have always obtained protection clauses from Parliament since they commenced opposition to those Bills in 1889. This is not quite accurate. Out of 50 cases protective clauses were inserted in about 40 cases *by consent* (given no doubt in many cases to save the heavy expense of a long parliamentary fight), and it was only in about 10 cases that the matter came before the committee. In the cases fought the results were by no means uniformly favourable to the Telephone Company.

The evidence given by the Telephone Company may be summarised as follows: The Telephone Company first showed that the currents used by the Telephone Company were infinitesimal, and not likely to do any harm to anybody else. That it was *cheaper* to them to dispense with a metallic return and to take the current back by means of gas-pipes, or otherwise by earth returns. That telephones had been decided to be within the terms of the Telegraph Act, and that in consequence telephonic messages being telegrams were only a branch of a business which had for 50 years been carried on by means of earth returns, and therefore obtained a prescriptive right to the use of the earth. That the electrical traction companies quite recently proposed to use earth returns. That the currents required for electric traction were very large and powerful. That leakage from or the inductive effects of these currents passing interfered greatly with the telephones. That the telephone company's lines could be protected from interference by using a metallic return and twisting the wires. That such steps could, however, only be carried out at enormous and prohibitive cost. That, on the other hand, it is very simple and inexpensive to prevent interference by insulating the conductors used for electrical traction.

The evidence upon which the Telephone Company have heretofore succeeded in obtaining protective clauses will show that the real facts of the case have never been fairly put forward, for it was to the following effect: That the same rules should be placed upon electric tramway cases that had been placed upon the electric lighting companies. That prevention of leakage to earth was solely a question of expense. That it was perfectly easy to insulate the two conductors in a conduit at an expense of about £40 per mile, whereas to lay down a metallic return to telephone wires would cost an enormous amount.

But electric traction cannot be governed by the rules placed upon electric light, for while nothing is easier than the insulation of electric light conductors from which the current is taken at fixed terminals, nothing is more difficult than the insulation of electric traction conductors where the current is taken by the arm of a passing tramcar. In the Folkestone case, where the cost of insulating the tramway conductors was put at £40 per mile, the decision of the committee was that if the Telephone Company required this done they must themselves pay for it, but the Telephone Company showed their faith in their witness's estimates by refusing the clause and allowing the Bill to pass without any protection to them. As a consequence, they had to pay the promoter's costs, amounting probably to more than the cost (on their estimate) of insulating the tramway conductors.

The telephone service with earth returns is admittedly defective. The use of a metallic return by the Telephone Company is not only possible, but would, it is admitted, prevent all interference, and the only excuse given by the Telephone Company for their failure to make their system perfect by this means is that of expense.

On the other hand, it has been shown that the use of electricity as a motive power reduces greatly the necessary cost of tramways, but that in practice it is not possible to insulate the conductors.

The matter resolves itself into the question whether *cheap traction* is to be prohibited in order that a *defective telephone* system may be maintained, or whether the Telephone Company should not be compelled to perfect its system, and by that means take away the reproach that its service is not only bad but retards the due progress of other electrical industries. And this is the real question that will have to be submitted to the Joint Committee.

Prima facie it may seem that there can be little doubt that the decision will be in favour of the traction interest. But in view of the strong position occupied by the Telephone Company, it behoves all corporations and local authorities and all those who desire to see *cheap traction* encouraged and the telephone service improved to support in every possible way the Electrical Traction Association before the Joint Committee.—Yours, etc.,

R. E. Crompton. E. Garcke. Sydney Morse.

COST OF COOKING BY ELECTRICITY.

Sir,—Your attention may have been called to a note in a contemporary interested in gaslighting, criticising Mr. Crompton's lecture at Hove, and making a comparison between the cost of electric heating and the cost of coal. Taking electricity at 5d. per unit, the price of coal, it is stated, should be equal to £7. 7s. 1d. per ton. I should be glad if you would allow me an opportunity of pointing out to your readers that Mr. Crompton in his lecture told his audience that electrical heating, although it appeared costly calculated in the manner adopted by the paper referred to, is not so in reality when the heating has to be applied for short periods of time, and only at such points where it is actually required. A large number of cooking operations come under this head.

The theoretical value in heat units of a ton of coal and its practical value when burned in the average stove are two different things. Probably about 50 per cent. of the heat passes up the chimney in the form of products of combustion, and this loss alone would double the price of coal when compared with electricity. For short operations coal is expensive, for a fire is of little use during the first half-hour of its existence, and when the fire is done with a considerable amount of heat is lost in its expiring embers. With electricity the matter is very different, the full heating effect of the current is experienced almost instantaneously, and owing to the fact that there is no combustion the heated conductor may be enclosed within, or attached to, the apparatus in use. Thus practically the whole of the heating effect is utilised, without waste in starting or stopping, for immediately the work is done the current is switched off, and no loss is experienced. From the above facts I consider a fair comparison of electricity with coal would be as 2 to 1. This is for some cooking operations, but not all. Thus the electric oven completely turns the tables on its opponents. The oven, which is entirely enclosed, is heated, say, to 400deg. in 15 to 20 minutes at double the cost of gas or coal; but as there are no means for the heated air to escape, the electricity may be entirely turned off when this heat is attained. But for the fact that there must always be some slight loss of heat through the walls of the oven, no more heating would be required. By allowing, however, 25 per cent. of the original current to pass through the oven, the full heat may be maintained, and cooking operations carried on indefinitely. Therefore, if electricity costs twice as much as gas or coal to heat up the oven in the first instance, it only costs half as much to keep it going.

I have tried the experiment of heating up an electric oven to 400deg. F., and after shutting off all current, taken tests for the next two hours. At the end of that time the temperature was still 250deg., which is sufficient for many cooking operations originally commenced at a higher temperature. The cooking carried on during the last two hours would not have cost a single cent—in fact, the electric oven acts like a baker's oven, which, being heated early in the morning, has to cook afterwards by means of the heat retained.

It is a very simple matter to calculate the cost of carrying out small cooking operations. For instance, taking the usual pressure of 100 volts, a unit will give us 10 amperes for one hour. For heating purposes electricity is supplied by many companies at a lower rate than for lighting, owing no doubt to the fact that cooking is mostly carried out during the day. Taking the price at 5d., we get the following: A large size electric toaster will toast perfectly two rounds of bread in one minute. The toaster takes seven amperes at 100 volts. If this apparatus is used for one hour it will cost seven-tenths of 5d.—*i.e.*, 3½d. At the rapid rate, however, at which this toaster will work, it will probably not be required more than 10 minutes at a time, and the current for this would cost one sixth of 3½d., or a fraction over ½d. Three minutes, however, must be allowed for the toaster to get to its full heat before using, and therefore we must add one-twentieth of 3½d. We may very well say that the toaster will work in the most efficient and satisfactory manner for about 10 minutes at a cost of less than 1d.

The electric griller will grill four chops or six cutlets in 10 or 12 minutes, using six amperes. Add to the time taken in actual cooking three minutes to heat up the plate in the first instance, and we find that current will be required for about 15 minutes at six amperes. The cost of this would be about 1½d. It is convenient to remember that at 5d. a unit we are paying ½d. per ampere per hour. To boil a quart of water requires about 3½ amperes for 10 minutes, but if we allow a quarter of an hour for this operation the cost is about ½d. It is quite a question whether the usual spirit stove would be as cheap.

If we add to the above the many great advantages and savings due to the absence of waste heat, smell, smoke, and dirt, the cost of electric heating for cooking purposes is certainly very little, if at all, in excess of coal. I doubt very much, when all the by-savings are taken into consideration, whether it is dearer at all.

The above figures are taken on the assumption that electricity is supplied at the price of 5d. per unit. It may be obtained, however, at 4d. per unit at the present time in the City for heating purposes, and in other parts of the country it is as low, and at St. Pancras it is charged at 3d. These prices make the comparison still more favourable. The convenience of being able to switch on or off the heating power at will, and to carry on the cooking operations in any part of the kitchen without reference to chimney accommodation will certainly bring electric cooking into favour.

Large numbers of experts have seen the Crompton electric cooking apparatus, and without exception they have declared in favour of its use. The only point which seems to cause them any doubt is the question of safety, but this they soon see is only a "bogey" raised by our opponents. There is absolutely no more danger to life or limb in using electric cooking apparatus than in the use of the ordinary incandescent lamps, for all are worked with the same pressure.—Yours, etc. H. J. DOWSING.

Train-Lighting.—MM. E. Sartiaux and E. Jacquin have issued a pamphlet on the use of oil lamps and electricity on the French Great Northern Railway, which is published by Veuve Ch. Dunod at Paris.

LEEDS.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

On Wednesday last week the central-station works in Whitehall-road, Leeds, were officially opened by the Mayor of the city of Leeds (Alderman Ward). The history of electric lighting in Leeds might be graphically told, but "all's well that ends well." The central station exists, current is being satisfactorily supplied. All that is now wanted is more customers and an extension of the station. We have attended a good many ceremonies, but we never remember to have heard a better series of speeches than those at Leeds at the inauguration of the station, and after the banquet subsequently held at the Queen's Hotel. Every speaker seemed in his happiest vein, speaking sound common sense and to the point. With such speeches, however, we have now little to do, our business being to describe the works, and for this description we cannot do better than give it as supplied to us by Messrs. Hammond and Co., the consulting engineers.

In the Board of Trade regulations issued in conjunction with the provisional order granted to the company the system of supply is defined as: "A high-pressure alternating-current transformer supply at constant pressure to transformers fixed at first in suitable positions on consumer's premises; but when a sufficient density of supply has been secured the distribution will be carried out by means of low-pressure distributing mains fed from converting stations. The distributing mains consist of continuously insulated cables laid in cast-iron conduits under the footways where possible."

The first care of the directors, acting under the advice of their consulting engineers, was the choice of a site. It was deemed advisable, if at all possible, to secure one that would have the advantage of a good supply of water, so that the company could benefit by the employment of condensing engines, at the same time secure the most economical situation for delivery of coal, and be sufficiently near the area of supply to keep the cost of the cables within reasonable limits. The site selected is in Whitehall-road, and admirably fulfils the requirements above stated. It has a frontage to the River Aire of 94ft. 6in., a total length of 290ft. 9in., while the width varies from the frontage to a maximum of 210ft. at the end opposite to the river.

Plans and specifications being prepared by the company's engineers, tenders were publicly invited, and some 26 tenders were received on May 26, 1892, for the supply and erection of generating plant either in whole or in part. Tenders were also received for the erection of buildings, the plans for which had been prepared by Messrs. Milnes and France, architects, of Bradford, and the works were given out as follows:

Buildings.—Gould and Stevenson, for mason and joiners' work; J. and H. Smith, for ironwork; Mr. Joseph Lindley, Mr. H. Season, T. Cordingley and Sons, and Mr. E. W. Walker, for plumbers', slaters', plasterers', and painters' work respectively.

Generating Plant.—Including engines, boilers, dynamos, switchboard, converters, and all accessories, John Fowler and Co., Leeds.

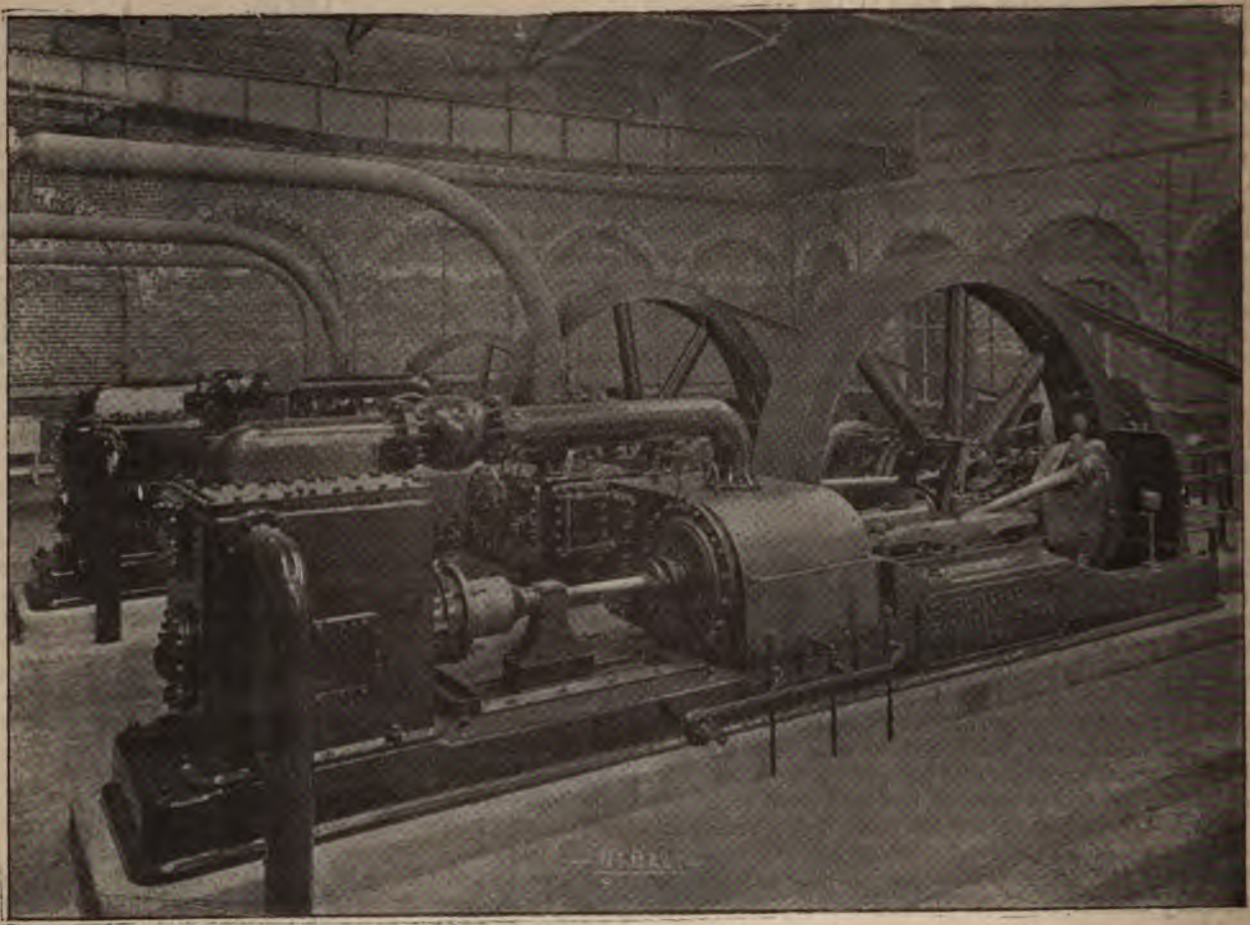
Meters.—The Westinghouse Electric Company, Limited.

Cast-Iron Pipes and Boxes for Street Culverts.—The Stanton Ironworks Company.

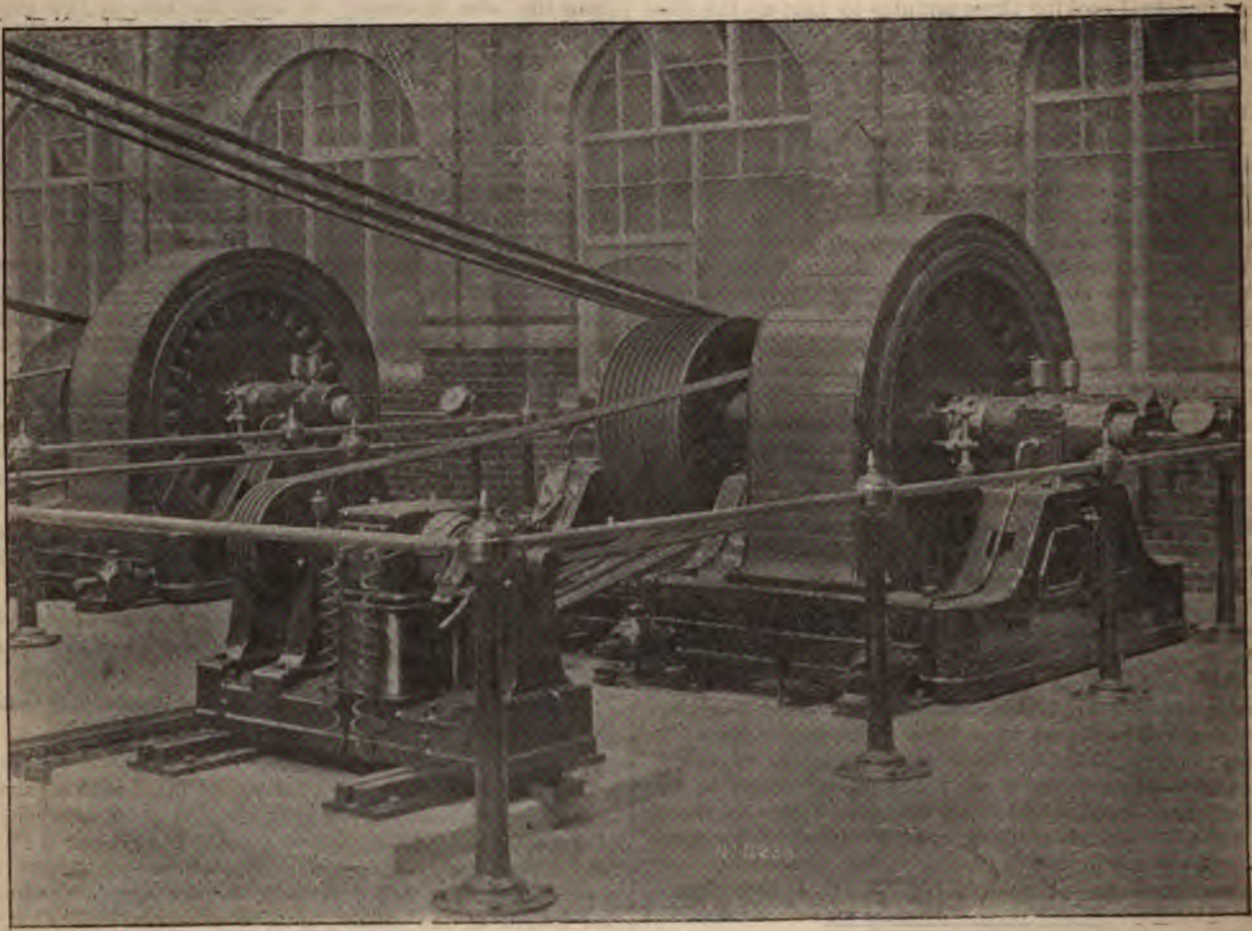
Indiarubber-Covered Cables.—The India Rubber and Gutta Percha Company.

BUILDINGS.

The engine-house is large, lofty, and fitted with a travelling crane, which spans the entire engine-house, the length of the span being 63ft. Directly behind the south wall of the engine-house are placed the boilers, as nearly as possible in line with the engines; this arrangement reduces the length of the steam-piping to a minimum. This is important both for economy and safety, as the strains due to expansion and contraction are minimised. Opposite the front ends of the boilers are the coal-bunkers. The position of these make stoking very easy, there being such a short distance between the furnace and the coal. Between



Engines at the Leeds Installation.



Alternators and Exciters at the Leeds Installation.

the coal-stores and the river is an ample wharf, on one side of which are placed the outhouses, water-tanks, filters, etc. The whole of the buildings are arranged in the most compact form, and conduce in every way to economy in working and easy supervision.

The engine-room is 68ft. long by 63ft. wide, and it is ended by the company's engineers that the question of ving sufficient space between the sections of machinery most important one for the safe and proper working of lectricity works. The plant installed in this place ists of two 200-i.h.p. engines; one 100-i.h.p. engine; 100-kilowatt alternators; one 50-kilowatt alternator. plant being capable of supplying electricity for 7,500 att lamps actually burning, or about 15,000 similar s installed in the houses.

e engineers of the company, Messrs. Hammond and urge that the plant does not consist of machinery h has simply been taken haphazard from the ordinary inery lists, and put down to do the work in ques- It has been worked out from the results of years xperience and careful observations which have used to adapt the plant to the special work h it had to perform, it being a recognised fact that equirements of moving machinery for electric lighting aps exceed all that has ever been demanded in any other ch of engineering. The type of engine selected is that vn as the horizontal coupled compound-condensing , the size of the larger engines being arrived at as a ble unit to work in sections, having regard to the irements of the business. The speed of the larger nes is 90 revolutions, the ordinary working pressure is b. per square inch, but the engines are capable, by asing the steam pressure to 140lb., to work up to i.h.p. as a maximum load. The remaining chief nsions are: High-pressure cylinder, 14in. diameter; pressure, 25in. diameter; stroke, 30in. diameter. slide bars are made separate in two pairs to each der in such a way that easy adjustment is possible. ther point in these engines must not be overlooked— the massive character of the bed-plate, where it is found elsewhere that nothing like the weight is given ay be here witnessed. The strength of the crankshaft, length and surface of the bearings is also a notice- feature, as also the size and weight of the flywheel.

(To be continued.)

COMPANIES' MEETINGS.

EST INDIA AND PANAMA TELEGRAPH COMPANY.

e ordinary general meeting of the West India and Panama raph Company, Limited, was held on Tuesday at Winchester e. The principal feature of the accounts was the increase in evenue of £2,217, with a decrease in the expenditure of £141. 0 was added to reserve fund. The traffic receipts showed an ase of £2,065, but it had to be borne in mind that this com- with the decrease of £7,350 which they had to report in the sponding period of the previous year owing to the reduced they were compelled to initiate at that time. The colonies inidad and St. Lucia had reduced their subsidies. The num numbers of directors was reduced to four instead of six.

LONDON ELECTRIC SUPPLY CORPORATION.

ectors: James Staats Forbes, Esq., chairman; Major C. B. r, deputy-chairman; the Hon. Reginald Brougham; the Hon. the Earl of Crawford, K.T.; the Right Hon. General Wantage, V.C., K.C.B.; Sir Coutts Lindsay, Bart.; Joseph Esq.; Francis Ince, Esq. General manager: H. F. Lewis, Secretary and accountant: R. Steward Bain, Esq. Chief eer: P. W. D'Alton, Esq. Consulting engineer: Dr. J. A. ing, M.A., F.R.S.

ort of Directors and statement of accounts for the year g December 31, 1892, presented to the shareholders at the ordinary general meeting of the Company.

reports of Dr. Fleming and the engineer are appended . They describe the new works that have been carried out g the year, and the general condition of the Company's ns and plant. The measures taken to reduce the cost of cing the current and increase the efficiency of the gerating have proved satisfactory. Owing to the autumn being the period of the year when extensive alterations or additions to enerating machinery can be prudently carried out, the advan- gained were but slightly felt during the past year, but, as in the engineer's report, the current year will realise the full t of the work done. Further measures are being taken, as bed in the engineer's report, whereby the proportion of t sold to current generated will be largely increased. As a quence of the competition which has arisen among the several nies, the standard charge per unit has been reduced from o 6d. The electric current at its present cost being now about to that of gas, the Board feel justified in anticipating a extension of electric lighting. The increase in the number of lights supplied during the past year, particulars of which are given in the engineer's report, amounted to about 40 per cent. This rate of increase has been more than maintained during the first four months of the current year, and in face of severe competition. The Board regret that the year's working has resulted in a deficit of £3,914. 9s. 7d., which is partly due to the slow rate of increase of the business in the early part of the year, and partly to the diminution in the number of units sold per lamp installed. It may, however, be observed that a comparison of the accounts shows that whereas in the December quarter of 1891 there was a loss of £821. 5s., there has been a profit of £1,486. 15s. 10d. in the corresponding quarter of 1892, and that in the quarter ended March, 1892, there was a loss of £833. 13s. 1d., there has been a gain of £1,113. 8s. 6d. in the corresponding quarter of the current year. Major C. B. Waller, formerly manager and secretary, has been elected a director in the place of Mr. Arthur F. Wade, resigned. Mr. Henry F. Lewis, for many years general manager of the Western Counties and South Wales Telephone Company, has been appointed general manager; and Mr. R. Stewart Bain, the accountant, has—while retaining that post—been appointed secretary. The directors retiring, in accordance with the articles of association, are the Earl of Crawford, Sir Coutts Lindsay, and Lord Wantage, all of whom, being eligible, offer themselves for re-election. A form of proxy is enclosed herewith, which any shareholder unable to attend the meeting is invited to sign and return so that it may reach the secretary at or before noon on Monday, the 15th inst. The auditors, Messrs. Kemp, Ford, and Co., who retire in accordance with the articles of association, offer themselves for re-election.

Engineer's Report.—I have the pleasure to report that during the past year the working has been satisfactory, and that many improvements in mechanical and electrical details have been made with the best result; so that, of late, the interruptions in the supply of current have been few and unimportant. At the commencement of the year we had 35,100 lights connected. At the end of the year the number had increased to 46,197. Up to the present date the number amounts to 56,200 lights, and we have orders for a considerable number of lamps in course of execution. Important additions have been made to our generating and other plant. A new dynamo of 300 h.p., driven by a set of triple-expansion condensing engines, has been erected, from which we have obtained excellent economical results. This machine is able to deal with the early morning load during a considerable part of the year. A machine of similar size is now being built for us, which, when brought into use, will enable us to work our daylight load with greater economy than has hitherto been possible. These machines will constitute a useful auxiliary power, as they can be worked in parallel with the larger machines with considerable economy. The re-modelling of the two 625-h.p. dynamos has been effected, and the output of the machines increased from 8,500 lights to 12,500 lights each—an advantage which has been secured by a relatively small outlay. The high-tension transformers, which gave us so much trouble in previous years, have done their work well. This I attribute to the careful and intelligent manner in which these instruments have been overhauled in our repairing departments at Deptford. The trunk mains have worked satisfactorily during the year. They were very seriously threatened, and suffered considerable damage, by two fires which occurred on premises contiguous to the mains. To safeguard us in future from such consequences I am now laying underground mains in substitution for those affixed to the South-Eastern Railway parapet. When this work is completed the whole of our trunk mains will be underground, with the exception of the short section which crosses the river by Charing Cross Railway Bridge. During the year we have laid down eight miles of distributing mains, making a total of about 35 miles of this description of main, all of which is in a satisfactory condition. The whole of the distributing stations now in use are fully equipped with the permanent switching gear, and these stations are working well. The system for condensing the exhaust steam has been completed during the year, and has been in work for some months past with the economical and mechanical advantages which I anticipated. The generating and distributing plant has been kept during the year in good order, and is working to my entire satisfaction.

P. Walter D'Alton, Engineer-in-Chief.

Consulting Engineer's Report.—I have read the report of your engineer, and substantially agree with the same. In addition to the remarks made by him, I may add that at the beginning of the year 1892 I began to carry out a careful series of experiments on the energy losses in the house transformers. The result of this investigation was to show that an immense improvement could be effected in the Corporation's system by replacing the existing house transformers by others of a more modern type. This work you have now sanctioned, and it is being carried out, and the result will be to effect a great economy in fuel. In the course of these experiments we discovered a very simple method of regulating electric pressure, which we have applied to the trunk mains with satisfactory results, in that we are now able to connect and disconnect mains without producing changes of electric pressure injurious to them. The high-tension transformers have during the last year given very little trouble. The methods of connecting and disconnecting them to the circuits have been so far perfected that failures of these transformers are now very rare. When the replacement of the whole of the house transformers is effected, and when the other improvements described by your engineer are all fully at work, I think there is every reason to believe that the system of supply will, so far as economy and efficiency of working is concerned, compare very favourably with other systems.

J. A. Fleming, M.A., D.Sc., F.R.S.

Revenue Account Year ending Dec. 31.

Dr. A.—Generation of Electricity.				£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing same on the works				8,128	2	5
Oil, waste, water and engine-room stores				1,437	7	0
Salaries of engineers, superintendents, and officers				871	0	0
Wages and allowances at generating station				2,889	12	4
Repairs and maintenance as follows:						
Buildings	£223	11	7			
Engines and boilers	502	5	7			
Dynamos and exciters	342	18	11			
Other machinery and tools	133	11	7			
Transformers and accessories	170	12	3			
				1,372	19	11
B.—To Distribution of Electricity.				14,699	1	8
Salaries of superintendents and officers	332	3	2			
Wages to linesmen, fitters, etc.	1,220	16	2			
Repairs, maintenance, renewals, and charges of mains of all classes, including materials, and laying same; also wayleaves	1,650	17	0			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	904	9	10			
Repairs to buildings	112	19	1			
				4,221	5	3
C.—To Rents, Rates, and Taxes						
Rents payable	1,222	10	2			
Rates and taxes	1,720	18	6			
				2,943	8	8
D.—To Management Expenses.						
Directors' remuneration	1,548	0	0			
Salaries of manager, secretary, engineers, clerks, and messengers	2,655	2	9			
Salaries of canvassers and meter readers	475	0	0			
Stationery and printing	147	4	10			
General establishment charges	587	9	3			
Auditors	52	10	0			
				5,465	6	10
E.—To Law and Parliamentary Charges.						
Law expenses	302	11	0			
Compensation claims	14	19	8			
Board of Trade audit	70	0	0			
				387	10	8
Stores at Dec. 31, 1891				479	15	8
				£28,196	8	9

Cr.	£.	s.	d.
Sale of current, less discounts and allowances	21,639	2	2
Sale of current under contracts	359	1	3
Rental of meters, converters, and other apparatus, on consumers' premises	1,452	15	10
Sales and repairs of other apparatus	180	12	8
Transfer fees	12	2	6
Students' fees	49	17	3
Running stores on hand at Dec. 31, 1892—Coal, £305; oil and sundry stores, £283. 7s. 6d.	588	7	6
By balance	3,914	9	7
	£28,196	8	9

Net Revenue Account, 12 months ending Dec. 31, 1892.

Dr.	£	s.	d.
Balance from last account	6,151	19	1
Depreciation on alterations to offices and stores	262	12	6
,, ,, office furniture	41	16	0
Interest on debentures	709	16	9
Law charges and stamps on debenture issue	382	12	7
Revenue account balance	3,914	9	7
	£11,463	6	6

Cr.	£	s	d.
Balance	11,463	6	6
	£11,463	6	6

Dr. General Balance-sheet, Dec. 31, 1892.	£	s.	d.
Capital account: Amount received	836,390	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1892	6,228	10	11
Sundry creditors on open accounts	8,193	6	10
	£850,811	17	9

Cr.	£	s.	d.
Capital account: Amount expended for works	820,739	16	7
Cash at bankers: Messrs. Coutts and Co., £1,157. 2s. 2d.; Messrs. Glyn, Mills, Currie, and Co., £182. 19s.; London and County Bank, Deptford, £90. 9s. 11d.	1,430	11	1
Cash in hand	31	16	9
Sundry debtors for current	7,953	11	11
Other debtors	8,604	7	5
Net revenue account	11,463	6	6
Running stores on hand at Dec. 31, 1892	588	7	6
	£850,811	17	9

The sixth ordinary general meeting of the above Company was held on Wednesday, at the offices, 3, Adelphi-terrace, W.C., under the presidency of Mr. James Staats Forbes, chairman.

The Secretary, Mr. R. Stewart Bain, read the notice convening the meeting.

The **Chairman** said that the report which had been sent out was the exhaustive statement of the engineer and scientist, and must have satisfied the minds of many absent friends, although it would have been more gratifying had there been a larger attendance. In order that the shareholders might appreciate more fully the position of the Company, they had insisted during the past two or three years upon presenting reports from the engineer and scientific gentleman upon whom really, in the long run, the success of that and similar undertakings depended. He was afraid they knew too well that their misfortunes, so far, had entirely rested upon the want of knowledge, which was pretty universal, as to electrical possibilities. Disasters had occurred on one or two occasions, when their whole business was stopped for considerable periods, and that had affected the public mind. They were in a very unfortunate position. They thought—everybody thought—that this undertaking was started on a highly scientific and economical principle, and if it had acted perfectly it would have been. It was a fact that the principle, however good, had more or less broken down in practice. He was laying the ground for the necessity of patience. In order that they might realise the effect of the irregularity and breakdowns from time to time, he might tell them that they were in this position: In May, 1890, at the time of the terrible catastrophe—the fire at the Grosvenor Gallery—they had 38,272 lamps connected; the number immediately dropped to 900. These, of course, speedily ceased altogether, so that they began business at that date. In May, 1891, they had worked their way back to 23,000. They had in 1893 increased to 56,900 lights, and the undertaking now really looked as if it was something like an efficient machine. If anything like the same progress was made in two future years that had been made during the past two years, they would then be out of trouble. The question was, because the results had not been advantageous owing to causes which, however unfortunate, were intelligible, whether they were to throw up the sponge and retire from the business. He did not think that was the disposition of their advisers or of the shareholders. Although the report was not one upon which they could very much congratulate each other, it still presented the element of future hope, and rational belief was that the multiplication of customers would go on and therefore the receipts would increase, whereas a large portion of the expenses would remain stationary. It was an unfortunate state of affairs that their receipts in 1891 were £28,684, and that in two years they should only reach £24,281. The expenses in both those years were exactly the same—£28,704 against £28,196, the intervening year, which was a disastrous one, having shown even worse results. Therefore the point which he would advise shareholders was to study carefully the report of the engineer, because the directors of a commercial undertaking were not scientists, nor could they control the elements; they could exercise a certain amount of judgment and control, and that most difficult and appreciated of all gifts — discrimination as to the value of opinions, and any other matters of old history or old experience. It was not difficult to come to that conclusion, but in this electrical business it required a very clever fellow to discover whether the scientist was right or wrong. The report of the engineer showed that during the year they had had a good deal of work to get through. It all came back to this. They had started with a too magnificent idea. It was thought that the multiplying of power would be a great economical advantage, and so it would have been if that power could always be kept fully occupied; but the gentlemen who were led away by that idea seemed to have forgotten that electric lighting was a thing which was not constant. Lighting began with a low demand, it culminated at a certain stage with a heavier one, and then it subsided into a lower one, so that if they started with machinery of one uniform type calculated to produce the maximum at the moment of highest demand, it was obvious that they must be working at a great loss in the earlier and later stages. What appeared, therefore, to be the practical conclusion of many people was that it would have been wiser to have had a smaller unit instead of having two 5,000-h.p. dynamos and two 1,250-h.p. dynamos. However, there it was, and they must make the best of things as they were. During the year they had spent a little money on starting a new unit of 390 h.p., and another was in course of construction, which looked very much like having to abandon, at all events at present, and perhaps for a long time to come, any idea of working with machines of such enormous power as of 5,000 h.p. As they knew, the plant consisted of two 625 h.p. and two 1,250-h.p. dynamos, which were all at work, but the latter were not without drawbacks. Well, it all came to this—whether the remodellings and experimental improvements were in the right direction. They believed they were, and had reason to adopt the report of the engineer, who, in modifying certain parts of the machines, had got to that position where they would do things which it was greatly to their interests should be done. They could work with regularity, without continual serious breakdowns, and with more economy. They were suffering, and should suffer—it seemed to be the result of shortcomings. They had lost their character with the public, and, unfortunately, they had lost their "turn"; an expression which he explained by reference to people waiting in turn outside of the pit door of a theatre. They had to retrieve lost time. Now the thing was, would those figures form any encouragement to continue the business? So many lamps, so much; the greater the number of lamps, the larger the receipts; the greater the number of lamps, the less the cost per lamp. Whether they had 50,000 lamps or twice that number going, what was the possible average they got per lamp? They started with contracts at so much per lamp per annum. When they began to do so, and almost until recently, it was impossible to trust any known method of measuring what they produced or sold. Happily, in the interim they had introduced meters, and the character of their business had entirely changed. A very large portion of their income had been derived from contract rates, but at present it was by meters. As far as the Board of Trade unit was concerned, there was a formula which had puzzled both himself and the shareholders. They were authorised to charge 7½d. per unit, and the success of this and similar undertakings turned upon how much they could produce a unit at. The sale price really depended upon the multiplication of the lamps. They would be in a different position in the next two years, because they would not be attended by double the cost of production. The great crucial test turned upon the most minute calculations of a minute quantity. If they could sell at 6d. and produce at 4d., then anybody could calculate how much so many hundreds or thousands of lamps in a year would do. It did not want such a very large number to place them in comparative prosperity. They believed that the machinery they now had at Deptford, with the exception of the enormous dynamos, which were only partly constructed, would enable them to light 90,000 lamps Just for the sake of argument, let them suppose that the 90,000 lamps averaged 10s. per lamp; that would give an income of £45,000. Their income had not been £24,000 during the past year, and the difference between the two was very considerable. Their expenditure had been £28,000, which would go a long way towards the additional number of lamps, and chiefly in coal. All the other enormous charges would remain the same amount per lamp, and what they had got to strive was to get that down. Of course all those things rested upon very small quantities, of which he would give them some idea. This (referring to a paper in his hand) was an analysis of what it cost to produce a unit, 7½d. being the estimated Board of Trade value. There were 18 items comprised in ascertaining what it cost to produce what they sold for 7½d., or something less. He had tried to explain that a portion of that depended upon the quantity they produced, but the bulk of it was dependent upon the necessity of a fixed charge. In 1891 every unit they produced cost them 10·14d., of which 4·61d. was in generation—that was, coal, sundry stores, repairs, and maintenance, and the only thing there of a fluctuating character which would entail cost was the item of coal—namely, 2·36d. per unit. He supposed it was possible that coal might be a little more or a little less per unit. The hopes of the thing turned upon what could be done by multiplication of quantity. To show how important this was, he referred to the three months ending March last, when things improved. They had better organisation, the machinery was in better order, they had at some moderate expense improved the machinery, and by means of a condensing process they had diminished evaporation and reduced the consumption of coal. Therefore, already in March this year, which only included one month of condensation, they had reduced the price per unit from 8·06d. to 5·71d. What he wished to impress upon them was that of the 5·71d., the cost of every unit they sold in the March quarter this year, coal stood for 1·31d., and therefore all the enormous portions of 4·40 would be stationary, and would be diminished exactly in proportion as the units sold increased. The only item which would progress would be the coal, and the other item — the 4·40d. — would diminish until it got down to probably 3d. or 3½d. As regarded the price of coal, all the companies were possibly in a very bad position. The Directors looked into the accounts of the other companies, and they knew as much of the details of that item as all the companies in London as of their own. It was their business to compare them. He believed they were all between wind and water. They had all been guilty of an act of folly. He assumed that they were innocent of the want of prudence in competition; they had been unduly rushing down the rates. There was no reason why the standard, adopted after much enquiry and attention by the Board of Trade as a legitimate charge, should not have been maintained, at all events until they were out of the wood. When they were prosperous and were making proper reserves, they could then begin to give the public the benefit of the excessive profit; but that was not the case with any one of those companies. Notwithstanding that they were all in competition, and the rate had been reduced to 6d. He supposed, however, folly could hardly conceive going further than 6d. under existing conditions. He was not aware that the price of coal would be materially reduced—certainly wages were not a thing which were not likely to go down, and what with Eight-Hour Bills, dockers' unions, and things directly affecting coal, the tendency was rather in favour of coal rising rather than falling. In face of that a knockdown seemed to be an open question. What they had to bear in mind was a standard—what was the price which they could sell at. During the present year they would have to sell at 6d.; that was very material. He did not know what the result might be upon the accounts, but what he wanted the shareholders to carry away in their minds was to be accurately informed of the conditions affecting the sale, and be informed as to the probability of a sale. Now the Directors thought that the probability was greatly in favour of their sales increasing with some reasonable rapidity. When they got double as many lights as they had now, if they got them, it would make such a marked difference in the cost of production that there would be a considerable profit. Referring to the report, it only represented the bulk of the matter which was put by Mr. D'Alton, who was second in command under Mr. Ferranti, and in whom they felt sufficient confidence to make their chief engineer. Certainly their confidence was justified in Mr. D'Alton coping with the difficulties, and in improving the machinery into something like a going concern. Of course, Mr. D'Alton was a mechanic, more than a pure scientist—a most essential thing. He did not know what the pure scientists would come to if it were not for the mechanical brake put upon their exuberance of fancies. It was, of course, necessary to have the assistance of a scientist. There were tests to be made, and for those purposes they had secured the assistance of Dr. Fleming. They would see that he had added to the report his approval and concurrence in all that had been said by the engineer, whilst he had given them crumbs of comfort as to the result of the experiments. During the year there had been a great leakage loss from faults in the generating machinery and losses in transmission, which had affected the Company in a very serious way. For instance, of the current generated and put in the mains for transmission, only about 42 per cent. was sold in the shape of units, the remainder having disappeared. Fortunately they now knew how, and although the knowledge involved the spending of more money to a moderate amount, chiefly in transformers, the new transformers being constructed would reduce the waste so much that instead of selling 42 to 45 per cent., they would sell 70 per cent or more of the quantity produced. That of itself would make a vast difference. The Directors told them about competition in the report, which had this possible result—the less the cost of electric lighting the greater the probability of people resorting to it. He knew some people who adhered to gas because they compared a gas bill with one for electric current. They say this was 30 per cent. more than the gas bill. There were other considerations—one was sanitary, some were æsthetic, and some were connected with the decoration of walls, etc. Those advantages were not taken into account by those people. The Directors hoped that that knowledge would spread, and there was no doubt that it would; that would imply a development of their business. There had been a loss of £3,914. There was some comfort in that, because they had narrowly watched the progress of the enterprise from month to month, and the last quarter of the year and the first quarter of this year had reversed the condition in a degree which was satisfactory. In the December quarter there was a credit profit of £1,486, and in the March quarter, which would come in the total for this year, there was a credit profit of £1,113 as compared with last year. If that continued they would only have to wait a year or two to merge from a bad state to one of comparative satisfaction. He then moved that the report and accounts submitted be received and adopted.

The **Earl of Crawford**, **K.T.**, seconded the motion.

Mr. Birkin asked, concerning the enormous sum of £248,876 paid for the purchase of the business of Sir Coutts Lindsay, whether the purchase had proved satisfactory, and whether the present engineer was the gentleman who recommended the construction of the enormous dynamos which were of no use. It seemed to him that the business had to be reconstructed, and that was most unsatisfactory. He could not understand why they had paid £30,000 for redeeming debentures, when, after redemption, they had to create fresh debentures. The general expenses appeared to be greatly in excess of what they ought to be; they came to about £21,000 per annum, or almost as much as they earned. He opined that the Directors had been badly advised in wasting so much money, first with the big engines and then that enormous purchase. He regarded the report as most unsatisfactory, and that there was no prospect of earning any dividend. As the shareholders had exercised that patience so strongly hinted at by the chairman, he thought that the Directors should suspend taking their fees until the shareholders received a dividend.

Mr. Barham did not think that any board of directors had presented such a miserable report as that before the meeting. He did not know that they could blame them for spending something like £1,000,000 without a single penny being returned to the shareholders, but he did think if he had a seat on the Board that he would resign it to-morrow (the next) morning, because if he could not manage the affairs of the Company without losing about £12,000 a year, he would let somebody else do so. There was no debit made for depreciation, and with that it seemed they were losing something like £20,000 per annum. If the Directors thought that was a matter that they could take off their shoulders and place upon a scientific man, he did not consider it sufficient. He thought it was patent to every user of the light that a more mismanaged company did not exist. He was told that six weeks after he purchased his shares. He thought that for a body of gentlemen to go there to manage a company, to receive £2,000 a year for spending the shareholders' money to the extent of £12,000 a year, there was not a precedent for it in the city of London.

Other shareholders having spoken, the **Chairman**, in reply, asked whether they should be discouraged and chuck it up, or should they go on. He supposed the Board would recommend them to proceed, but he could not imagine anybody could have a greater interest than the Board in the undertaking being carried on successfully as far as possible, because the Directors were large holders. That was, he thought, a strong inducement, besides which they held a very fair proportion of the preference shares. He did not know any commercial undertaking of that kind where the directors had so much at stake. He also did not know of any where the directors were so deeply at work redeeming error. As they had said, the enterprise was started too magnificently, and science had not sufficiently justified the views. That was not an uncommon thing in commerce. No doubt the result was unfortunate, but he had endeavoured to make out that at starting where they had got to that they had waded through many difficulties, and they believed there was enough knowledge in the world now, and that the position of disaster had been sufficiently retrieved to make a future hopeful if they persevered in the course which he had indicated. He did not know that it was necessary to answer some of the questions. As to Mr. Birkins's question concerning the value of the Sir Coutts Lindsay undertaking, it was a matter of notoriety that the Company was founded upon an existing business. The purchase price of that was determined and was paid, as he understood, in shares, and those shares and a great many others were in the possession of the Directors and their friends, who were as disappointed as the shareholders; but they had retained their holdings. There was no doubt that Mr. Ferranti was a very extraordinary person. Like all men of genius he was a little in advance of his time. They could, of course, not wait for developments, but must use the best means until those machines could be utilised. The Directors had not seen their way during the past year to reduce the costs of administration, but they had decided to suspend their fees in future until the Company was in a position to pay them. Need he say anything more? He thought they had all to commiserate with each other upon a common affliction. They would pull out of that with a little tenacity, courage, and a good deal of hope. He knew they were subject to complaints with their customers, and that their lights went out, but they were not the only people who were similarly situated. They had, however, a loyal lot of customers, and they found that they were coming back to them.

Mr. A. Mansfield said if the Directors were in a position to assure the public that they could supply them as well as other companies, he thought a great mistake would be made if they did not send round to the different occupiers and assure them that they were in a position to do so. The Company had a bad odour in the West-end, and the Westminster Company was taking away their customers wholesale. If they could supply 90.000 lamps, why not do all they could to get customers?

The **Chairman** (continuing) said that the number of lamps was now 56,900, and that the Company could now supply 90,000. They were inviting customers up to 90,000 lamps, but no doubt people were greatly prejudiced by their previous misfortunes. It was a curious thing in humanity that one easily consoles oneself with the misfortunes of their friends. The Westminster Company had done so, and that was why that company had some of their customers. That company would have to suffer for it by and by; he supposed they were already suffering. Quite recently they (the London Company) had been subjected to a severe test, at a great London club, upon the distinct understanding that unless the use of their lights in that club (for a time strictly watched from day to day) were satisfactory, they should go out. Well, they had gone on, and the influence of that club had not only secured to them the lighting of the club, but also that of another of which the club had control. No doubt they had suffered, but when people found out that they were persistent and redeeming their misspent moments, they had a sort of sympathy, and he had no doubt they had a sympathetic number. As to advertisements and canvassers, they had several, and they got a certain number of customers. He believed they were making as substantial progress as any of their neighbours, and there was only one way out of the difficulty—enormous patience. He then put the resolution, which was carried *nem. con.*

The Earl of Crawford, Sir Coutts Lindsay, and Lord Wantage were re-elected directors, and Messrs. Kemp, Ford, and Co., were reappointed auditors at a fee of 50 guineas.

A vote of thanks to the Chairman terminated the proceedings.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

The first annual meeting of the Yorkshire House-to-House Electricity Company, Limited, was held last Friday at the offices of the Company, Whitehall-road, Leeds. Mr. Grosvenor Talbot, chairman of the Board of Directors, presided.

The **Chairman** moved the adoption of the report and balance-sheet, which has already been published. He explained that it only showed a very small part of the work which had been done, dealing as it did with the period ended December 31 last. Since then they had considerably advanced; they had opened their works, and they should have very much more to tell the shareholders a year hence. The Directors considered they had done well, and the presence of a large number of people from various parts of the country at the opening of their works showed that there was evidently great anxiety on the part of many of the large towns of the United Kingdom as to obtaining the best system of electric lighting. They trusted their works were on the best existing plan, and there was every reason to believe that they would be efficiently conducted by the Directors, because their coal and water were cheap and their situation was good. They felt sure that their works would be keenly criticised, but he hoped they would do everything in their power to make them a success. He thought the shareholders would join in the opinion of the Directors that so far they had proceeded in the right direction, and it now remained for them to go further, and to make the works they had commenced a successful paying concern. They could with their present plant provide for 5,000 or 6,000 lamps more than they were now supplying, and they trusted that when these were taken up they should be able to get additional capital for the extension of their plant. They could now supply electric light in every part of the city included in their circuit, and their circuit, he might add, embraced Headingley and the route to it by Woodhouse-lane. In conclusion, the Chairman explained that the expenses in connection with the opening of the works would not fall in any way upon the shareholders.

Mr. Robert Hudson seconded the resolution, which was *agreed to.*

Messrs. Robert Hudson and Samuel Ingram were then reappointed directors, and Mr. John Gordon, jun., was re-elected auditor.

In reply to Mr. Armitstead, who said that he knew of several persons in Lowerhead-row who were wishful to have the electric light, the **Chairman** stated that it was a question of cost. They had only raised sufficient capital to cover a certain area. They had done that completely, and at present they could not expend much more money on laying mains, because their capital was exhausted, with the exception of what remained for maintaining their works. They should be extending to Lowerhead-row very soon, and if Mr. Armitstead's friends would send in applications they should be taken into consideration, and they would see if any plan could be devised for taking the plant there. In reply to a question, the Chairman further stated that with the existing plant they could supply 16,000 eight-candle lamps, and that between 10,000 and 11,000 had been applied for up to the present.

On the motion of **Mr. R. H. Fowler**, of London, seconded by **Mr. Clough**, a vote of thanks was accorded to the Chairman and Directors, and the proceedings then terminated.

BUSINESS NOTES.

Aston.—The Aston Technical School is to be lighted throughout by electricity at a cost of £1,400.

Elmore Copper.—The firm E. Secrétan et Cie. has been established in France for the purpose of taking over the Elmore Copper Works at Dives, Calvados.

Nelson.—The Local Government Board have sanctioned further borrowing powers of the Nelson Town Council to the extent of £6,080 for electric lighting purposes.

Lancaster.—The Corporation of Lancaster require by the 23rd an electrical engineer to superintend the construction and working of the borough electric light installation, at a salary of £120 a year.

G.N.R.: Holloway.—The Great Northern Railway Company have accepted the tender of the Brush Electrical Engineering Company for arc lamps and accessories in connection with their central station at Holloway.

Sales.—Messrs. Duncan Keith and M'Cloy advertise the sale, for the 30th inst., of the machinery of the Woodside Electric Campany. The plant and machinery of the Lea Telegraph Works (late Phillips Bros.) is to be sold by private treaty.

Colombo.—Anyone wishing to utilise the services of an electrical engineer in Ceylon and the East might make a note of such a one "experienced in dynamo-designing, central-station, and installation work," at the address A.I.E.E., Post Office, Colombo.

City and South London Railway Company.—The receipts for the week ending May 14 were £787, against £709 for the same period last year, or an increase of £78. The total receipts for 1893 show an increase of £1,333 over those for the corresponding period of 1892.

Stabilit.—The new insulating material "Stabilit," to which we alluded last week, is being introduced into this country by the Electrical Company, Limited, of 122, Charing Cross-road. The material has passed satisfactory practical trials, and will evidently prove of much utility.

Electrical Supplies and Fittings Company, Limited.—Mr. Justice Williams, on Wednesday, made an order continuing the voluntary winding up of this Company under the supervision of the Court. Mr. G. F. Hart, Mr. George Lawrence, and Mr. Isaacs were the counsel engaged.

Change of Address.—Crosier, Mills, and Co. are removing their offices from 9, Queen-street to 58, Collingwood-street, near the Central railway station, Newcastle-on-Tyne, where they will also have a showroom for the display of carbons, machine tools, Mills' boat gear, Cromil bronzes, and other engineering specialities.

Bristol.—At the quarterly meeting of the Bristol Town Council last week, the report of the Electrical Committee, recommending the acceptance of the tender of the Brush Electrical Engineering Company, Limited, for transformers and fittings at £1,752, and of Mr. F. M. Newton, at £1,553. 16s. for switchboards and accessories, was adopted.

Final Decision at Edinburgh.—On Tuesday, by a majority of 23 votes to 17, final approval was given to the resolution of the Edinburgh Corporation to retain the electric lighting of the city in their own hands. We congratulate the upholders of Council ownership on the result. The work should now be put in hand as soon as possible.

Isle of Man Electric Tramway.—The Douglas and Laxey Electric Tramway Bill was passed unanimously by the Council of the House of Keys yesterday. This line will be one of the greatest public improvements on the island, passing along the coast to Laxey. The section of the line to the famed glen of Groudle will be opened on July 15 next.

Southampton.—At the Southampton Town Council meeting the town clerk stated that he had received a copy of the receipts and expenditure of the Southampton Electric Light and Power Company for the past year. A letter was read from the Local Government Board sanctioning the borrowing of £400 for the lighting by electricity of the free library.

King's Cross.—The work in connection with the lighting of the new offices at King's Cross for the Great Northern Railway Company has been given to Messrs. Drake and Gorham, 66, Victoria-street, Westminster, S.W. There are to be 636 lights installed, and the whole of the tenders received were exceedingly close. Mr. A. H. Preece is the consulting engineer.

Caledonian Station (**Edinburgh**).—The electric light at the Caledonian Station, Edinburgh, which has been installed by the Brush Company, was turned on last week for the first time by Mr. Dunn, telegraphic superintendent of the Caledonian Railway. Only 40 arc lamps were lit, but the full installation will consist of 50 arc lamps and 1,000 incandescent lamps.

Coatbridge.—The Scottish House-to-House Electric Supply Company have concluded a contract with the Brush Electrical Engineering Company, Limited, for the complete equipment of a central electricity supply station at Coatbridge. The installation will be on the Mordey-Victoria alternate-current system, with the generators driven by "Griffin" gas-engines and Dowson gas.

Llangollen.—Mr. J. P. Davies, at the Llangollen Local Board meeting, explained in detail the scheme for electric lighting for the town of Llangollen, and moved that steps be at once taken to carry out the scheme. This was not agreed to, but the matter, on the recommendation of Mr. H. O. Thomas, was referred to a committee consisting of Messrs. J. P. Davies, J. E. Griffiths, H. O. Thomas, and J. E. Jones.

Fire Alarms at Stafford.—The Stafford Town Council have agreed to contribute £10 per annum towards the provision of electric bells for each member of the fire brigade, on condition that the brigade dispensed with the messengers and undertook to pay the costs occasioned by the change of residence or removal of its members. Alderman W. H. Peach said it was proposed to enter into an agreement with the National Telephone Company to fix and maintain the bells for £16 a year.

West Calder.—A movement has been in progress for some time to improve the lighting of the streets in West Calder (Scotland), and matters now appear to have come to a practical issue. A deputation laid a proposal before the committee of the West Calder Co-operative Society that they would pay for the erecting of arc lamps throughout the streets if the society gave the electric current from their dynamo free of charge. The society have agreed to this proposal, and steps will at once be taken to erect the lamps.

Newport.—Prof. Robinson, of King's College, has been called in to advise the Newport Corporation as to lighting the thoroughfares by electricity. The cost of the installation in the six principal streets in the centre of the town is estimated to be £30,560, and the annual cost of maintenance would be £5,650. For this sum 4,500 lamps of 16 c.p. could be provided. The lighting station and engines would be erected on Corporation land at Friar's Fields, and the low-tension continuous-current system on the three-wire principle is recommended.

The Telephone in Glasgow.—The new multiple telephone system, already in use in Dundee and Aberdeen, will be introduced in Glasgow by the National Telephone Company in the course of a few days. By the new system all the wires are duplicated, and of the two wires connecting each subscriber's office with the exchange, one is used solely for calling the attention of the operator. Improvements have also been made in the receiving-boards in the central exchange. In carrying out the change of system, about 200 miles of wire, weighing nearly six tons, has been used.

Newmarket.—At the last meeting of the Newmarket Local Board the clerk read a letter from the Board of Trade asking the Board if they had any remarks to make before the permission of the Board of Trade was given to the company to instal electric light, as the Board of Trade were doubtful as to the financial position of the company. After hearing the financial statement, Mr. Ellis proposed that a resolution to the effect that the Board would object to any company which was not in a sound financial condition, and would not take any responsibility in deciding whether the company was satisfactory or not.

Whitehaven.—The Whitehaven electric installation is progressing. The central station is now nearly ready, so far as boilers, engines, and dynamos are concerned. The work is intended to be completed in July. There are four dynamos, two being spare. There is space for other four dynamos, and these will be procured when the demand for private consumption warrants it. It is expected that Messrs. Siemens Bros. will be ready for the laying of the conductors through the streets in a week. Mains will be laid throughout the whole of the district at present lighted with lamps, and electric lamps will be placed in the present lanterns.

Newcastle Lake.—A sketch plan was exhibited at their meeting last week to the Newcastle Town Moor Management Committee, showing a very beautiful fountain, with the electric light at the top for the purpose of lighting the lake when frozen during winter months. This was referred to the engineer, in order that the mode of lighting should be considered and reported on at the next meeting of the committee. In the meantime, it was agreed that the engineer should lay down the connection across the bed of the lake to the island in the centre, to enable the committee, should they decide hereafter, to light the same with the electric light.

Elmore's Copper Company.—At the adjourned general meeting of Elmore's Copper Depositing Company last Friday, the chairman announced that the total promises only reached £12,000 of the £17,600 required. An attempt was then made to raise the balance of the sum required, and promises were received raising the amount to £14,800. The chairman announced that unless the remainder were forthcoming by Tuesday the deposits already received would be returned. A resolution was then passed that, in the event of the preference shares not being fully subscribed, a meeting should be called to consider the question of voluntary liquidation and reconstruction.

Yarmouth.—At the monthly meeting of the Yarmouth Town Council a petition, signed by 200 tradesmen and others, was read, asking the Mayor, on behalf of the inhabitants generally, to cause a poll to be taken to ascertain whether it was really the wish of the ratepayers that an electric lighting scheme should be undertaken by the Corporation. The Clerk said the Mayor had no power to order a poll to be taken. As application had been made to the Local Government Board to sanction the borrowing of £15,000 for electric lighting, a public enquiry would be held, of which public notice would be given. Any persons who were opposed to the scheme could attend and state their views. The Mayor requested the town clerk to advertise the enquiry in the local papers.

Electricity Applied to Farmwork.—An interesting example of electricity as applied to farmwork has been in operation for some time at Ardwell, Wigtownshire, the property of Mrs. Ommaney M'Taggart. The whole of the usual farm machinery—such as thrashing, sawing, corn-crushing, and the like—is driven by an electric motor. The electricity is generated by water power, the turbine wheel which drives the dynamo being about 1,000 yards from the farm. The power is conveyed by underground wires to the house and farm, in each of which a storage battery is placed. These supply current for lighting and motive purposes when the machinery is not working. There are many places in England and Scotland where water power now running to waste could be utilised in a similar manner.

Thompson Brothers, Limited.—This is the title of a company registered with a capital of £7,000, in £1 shares, to take over as a going concern and carry on the business of gas-oven makers, mechanical and electrical engineers, ironfounders, manufacturers of agricultural implements and machinery, toolmakers, brassfounders, machinists, etc., carried on by David Thompson and Charles E. A. Renny, under the style of Thompson Brothers, at the Crown Point Foundry, 11, East-street, Leeds. The signatories are: Mr. David Thompson, Mr. Charles E. A. Renny, Mr. Ernest A. Thompson, Mr. John Thrippleton, and Mrs. Isabella Thompson, Leeds, and Mrs. Annie Renny and Mr. Alfred Johnstone, Bradford. Mr. David Thompson is the managing director, with a salary of £150 per annum. The registered office is at the foundry in East-street, Leeds.

West African Cables.—An important deputation of African merchants waited on the directors of the African Direct Telegraph Company on Monday to point out that reduced charges, with certain safeguards, would lead to more use of the cables, and result in an increase of revenue. They also urged that in the general interest, and in view of the development of the newly-formed oil rivers protectorate, that either a land line or telegraph, or a cable, should be established between Bonny and Old Calabar, and the chamber had recommended to her Majesty's Commissioner that a subsidy of £2,000 per annum should be paid by the protectorate to the company in consideration of the extension. The expression of the views of the deputation were carefully listened to by the representatives of the company, but the chairman stated that the company would be unable to make any concession unless the Government came to their assistance.

Dundee.—At the monthly meeting of the Dundee Police Commission, Mr. Smith directed attention to the minute of the Lighting Committee, of date May 2nd, in which the following account appeared as having been passed: "To supply of electric current for four arc lamps on High-street from March 15th to April 30, 1893—429½ hours—859 Board of Trade units, at 5d. per unit, £17. 17s. 11d." He said their agreement with the electrical department was that these lamps were to cost £25 each per year, and they would notice that this was on an altogether different footing. At the rate of £25 per year the cost would be about £12 instead of this. He had refused to sign the account, but it appeared in the minutes as if it had been passed. Ex-Provost Ballingall remarked that this was simply an approximate estimate. Mr. Smith replied that at first it was an estimate, but it was afterwards arranged. It was agreed to delay the consideration of the matter.

Folkestone Electric Tramway.—At the Folkestone Town Council meeting last week, Councillor Blaxland moved that the required sanction be given with reference to the electric tram without sending a deputation to Leeds as previously decided upon. He described the result of his experience of the tram at Leeds. He had taken the trouble to go there and examine the system, and he was convinced that its introduction into Hythe would be a great benefit to the town. The poles were unsightly, but these could be altered; and as to the objection that horses would be frightened, he saw no fear of that, and he considered that they could not do better than give Mr. Sellon leave to go with their consent and make arrangements with the South-Eastern Railway Company. He heard that the Rev. Russell Wakefield had been down there and expressed his satisfaction, and he thought they might communicate with the Sandgate Local Board, and get its co-operation in the matter. Councillor B. Horton seconded the resolution. They were very much obliged to Mr. Blaxland, and his report did away with the necessity of sending a deputation to Leeds. The resolution was unanimously carried.

Telephone Charges.—"The managers of the National Telephone Company," says the *Sunderland Herald*, "have decided upon a new departure to which we invite the attention of renters, in the hope that steps will be taken to secure joint action. Without giving a moment's warning, the company's agent or agents are submitting a new printed agreement for the signature of its customers. A marginal note explains that this cancels former agreement, but no hint is given of the fact that signatures to the new agreement involve a five years' and three months' engagement of the instruments at the least, and 'for 12 months' payment of the rents in advance.' Business men not blessed with a monopoly are very, very thankful if they can receive pay when their work is done, others try and get three months or six months in advance, but a full 12 months' demand must be a novel experience to many renters, and one that will not be willingly acceded to. In addition to this five years' agreement and 12 months' pay in advance, the lessees have to be personally responsible to the company for any damage, from any cause whatever, except fair wear and tear. In case of fire full recompense up to £7. 10s. per instrument is to be chargeable, and compensation at cost price paid for switches, switchboards, etc. With this new agreement in view, we may pertinently ask in what position would the owners of property be who give the company root-rests for the nominal acknowledgement of 1s. per annum in the event of damage to the company's property by fire."

Cardiff.—The Gas and Electric Lighting Committee of the Cardiff Corporation have received the following tenders for the erection of the first portion ot the electric lighting station :

F. Ashley, Cardiff	£4,272	4	4
W. Thomas and Co., Cardiff	3,323	3	2
T. D. Ridley, Cardiff	3,234	10	6
Ellis and Davies, Cardiff	3,254	17	7

The committee agreed to recommend acceptance of Messrs. Thomas and Co.'s tender. At a subsequent meeting of the Corporation, the recommendations were adopted. The buildings it is proposed to put up at the present stage will consist of an engine and dynamo house, 80ft. by 30ft. ; boiler-house, also about 80ft. by 30ft., which will contain five boilers and coal-stores, 60ft. by 14ft., to which runs a siding from the Great Western Railway. An octagonal chimney-stack, 150ft. high, with an external diameter of 17ft , has already been commenced by Messrs. Thomas and Co., West Bute Docks, the contractors. Both the building and stack will be faced with Ebbw Vale bricks, the stonework being blue Forest of Dean. The engine and boiler house and coal-stores will be surmounted with a wrought-iron lantern roof, possessing special features for ventilation. At the Town Council meeting on Tuesday a letter was read from the Local Government Board sanctioning the borrowing of £32,500 for electric lighting, to be repayable in 25 years. The Mayor (Mr. W. E. Vaughan, J.P.) was invited to perform the ceremony of laying the foundation-stone of the new electric lighting station. Twenty-four applications were received for the position of clerk of works at the new electrical station, Mr. W. Williams, of 17, Green-street, Cardiff, being elected.

Woodhouse and Rawson United, Limited.—In the case of this Company, already in voluntary liquidation, no fewer than four petitions were before the Court on Wednesday, asking for a compulsory winding-up order. Mr. Buckley, Q.C., and Mr. Percy Wheeler supported the first petition ; Mr. Farwell, Q.C., and Mr. Eustace Smith the second petition ; Mr. Grosvenor Woods the third petition ; and Mr. Upjohn the fourth petition. Sir Horace Davey, Q C., and Mr. George Lawrence were for Mr. Young, the voluntary liquidator ; and Mr. Cozens-Hardy, Q.C., and Mr. T. L. Wilkinson, Mr. George White, Mr. Eve, Mr. Oswald, and Mr. M. L. Romer were for creditors and others. Mr. Justice Vaughan Williams made a compulsory winding-up order on the four petitions. His Lordship, however, said he should not allow the costs of all the petitions ; but for the fourth petition a compulsory order would not have been made at all, as all the other petitioners were willing, when the case was previously before the Court, to accept a supervision order. The cost of only the fourth petition, therefore, would be allowed, but Mr. White's and Mr. Oswald's clients were also entitled to costs. His Lordship was not satisfied that there would not be a surplus to be divided amongst the unsecured creditors. The receiver appointed in a debenture-holders' action had stated that the assets were only worth a certain amount, but no one who had seen affidavits made by receivers could have failed to observe that they were apt to underestimate the value of the assets. Debenture-holders were often officers, promoters, or vendors, or persons nearly connected with them, whose interest it was to have as little publicity as possible about the winding-up. Here the receiver had not taken into account the large amount which was claimed against the directors. It had been suggested that it was £80,000. It might be that in the case of large concerns an experienced outside liquidator could do more than the official receiver could as liquidator, but where a case arose for enquiry it was better to have the intervention of the official receiver in a compulsory winding-up. His Lordship, however, intended to make no reflection on Mr. Young, the liquidator, who had given the Court valuable assistance.

Edinburgh.—A meeting of ratepayers of Canongate Ward, Edinburgh, was held on the 12th inst. to discuss the electric lighting question. About 150 persons were present, and Councillor Miller Dunlop took the chair. In opening the meeting, the Chairman explained the circumstances under which, a year or two ago, the Town Council came to apply for the electric lighting provisional order ; and he declared that at that time it was obtained the intention was not that the Council should itself work the light, but that it should be enabled to keep others out. He had voted against the town taking the light into its own hands, but if that meeting decided that he ought to vote the other way, he should do so, because in a matter involving taxation like this he placed himself in the hands of the ratepayers. Edinburgh was, he thought, the last place where the Corporation should engage in this sort of speculation. Councillor Cubie said statements that were being circulated as to increase in the rates by the city's working of the electric light were greatly exagerated. The whole sum required to pay the annual interest on the sum proposed would only be £3,000, representing only about one-third of a penny in the pound. Their past experience in connection with private companies had been unhappy and unfortunate. He was in favour of the Corporation working the light itself. Councillor Waterston, who followed, argued against the light being handed over to a company, and, citing the experience of the purchase of the gas concern, declared that transaction to be one of the greatest pieces of robbery ever perpetrated upon a corporation. The fact was that there was a lot of the surplus gas money of the ratepayers behind this whole agitation. He believed as solemnly as he believed in his own existence that to hand this light over to a company at the present moment would be fatal to the interests of the Corporation and of the ratepayers, and would bring them back to what they experienced in connection with the gas and water companies ; and while there might be an outlay for a year or two, it would soon be a great benefit, and what they would lose on the one hand by the decreased consumption of gas they would gain on the other. He had far more faith in trusting the Corporation than any company, which would not embark on the enterprise unless they believed that the history of the gas company would follow. After a number of questions had been answered, Mr. J. C. Stark said he thought the matter should be left to the discretion of their ward representatives. Mr. Robertson, seconded by Mr. Aitken, moved that the Town Council be requested not to take the electric light into their own hands, and that the ward representatives be asked to support that view. Mr. Ryder, seconded by Mr. Wilson, moved as an amendment, that the Corporation itself, and not a private company, work the light. On a division being taken by a show of hands, it was found that the motion had secured 45 votes, and the amendment 39. The proceedings then terminated.

Dewsbury.—At the monthly meeting of the Dewsbury Town Council last week the minutes of the Light and Water Committee were as follows : "Tenders for the engines and works necessary for the electric lighting of the area of supply within the borough were received, and referred to Mr. Preece, the consulting engineer. 25th.—Mr. Preece attended, and laid a report on the tenders for the central-station plant, with prices, and recommended that the lighting be on the continuous-current low-tension system, and that the tenders be selected from the Brush Electrical Engineering Company, Limited, Crompton and Co., Limited, Siemens Bros. and Co., Limited, all of London ; Johnson and Phillips, Old Charlton ; J. and J. Horsfield, Dewsbury (for boilers). The Mayor, the chairman, Councillor Birkhead, and the town clerk to wait upon Mr. Oldroyd, M.P., with an endeavour to induce the company of which he is the chairman to obtain the electric light for Spinkwell Mills from the Corporation, instead of establishing their own plant as contemplated. May 1.—A request from the Tradesmen's Association for the better lighting of Nelson-street was deferred to next season. Alterations were sanctioned at the gasworks so as to allow of the largest railway trucks entering the retort-house. The lighting of Birkdale-road, Victoria-crescent, and Park-road End was ordered to be improved. It was resolved that for the present no alteration be made in the scale of discounts on gas accounts. May 2.—The chairman reported that the sub-committee had had an interview with Mr. Oldroyd, who informed them with respect to providing the electric lighting plant for Spinkwell Mills, that they could not obtain the supply from the Corporation ; but that in the event of their desiring a supply of electricity at any of their other works or warehouses in the borough, they will consult with the Corporation. Mr. Bever (Bever and Dorling) waited on the committee to urge that the work in connection with the electric lighting should, as far as possible, be placed in the town. It was resolved : 1. That the provision for the lighting of the streets with arc lamps be dispensed with, except as to the laying down of tubes for the reception of mains at any future time. (Estimated saving in first cost, £2,000.) 2 That the system of lighting be the continuous-current low-tension system. 3. That the engines be Willans's high-speed direct-acting engines. 4. That subject to settlement of detailed schedules of prices, and consideration as to the employment of batteries, and other matters of detail, tenders be accepted—viz., Messrs. Horsfield, boilers ; Messrs. Crompton, engines, dynamos, accumulators, switchboards, etc. ; and Messrs. Siemens, mains (total amount £12,607). 5 and 6. That the town clerk prepare the contracts and obtain the sanction of the Local Government Board to the borrowing of £25,000. Mr. Preece's plan for buildings at the central station (the old gasworks) be accepted, and the sanction of the Local Government Board be obtained to the use of the land. An offer by Mr. Preece of a popular lecture on electric lighting was accepted with thanks." Alderman Robinson moved, and Councillor Archer seconded, the confirmation of these minutes. Combating an amendment, Alderman Robinson remarked that it had been thought advisable not to make any alteration in regard to discounts under the existing state of things. The committee considered that they were so near having the electric light, and that an alteration would mean a difference by discounts to the tune of £300, it would be the better plan not to alter the scale of discounts for the present. The amendment was lost. Alderman Fox moved that the minutes respecting the building of electric station be withdrawn. Alderman Walker seconded the amendment. Councillor Howroyd said he was rather disappointed that Alderman Fox had not attempted to put forward some reasons why the committee should withdraw the resolution. They had considered the matter very carefully, and they were of one opinion that the work of electric lighting should be got on with as quickly as possible. It was well known that if they had taken up the work sooner they would have had more persons to take the light, and by their delay they were not likely to have one very firm as customers that they had expected, at all events for one portion of their works. They considered it to be for the best interests of the borough to proceed with the works without delay. He thought before the Council should be prevented from carrying out the works at once valid reasons should be given by the members. Councillor Barstow said he had been wanting to hear Alderman Fox's reasons for requesting this matter to be referred back to the committee. He would remind both Alderman Fox and the other members of the Council that they had very seriously considered the question, and had come to the unanimous decision that it was absolutely necessary that they should push on with the works as fast as possible. Alderman Fox said that at a meeting of the General Purposes Committee a fortnight ago it was understood that this question should not be dealt with at the present meeting, but held over until the meeting in June. He did not see that his amendment would hinder the work of the committee at all, and he had no desire that it should do so, but what he desired was that they should have the fullest possible information as to the cost of the proposed scheme and other matters connected with the undertaking. The amendment of Alderman Fox, on being put, was lost by twelve votes to four. The minutes were then adopted in their entirety.

Price of Electricity.—Mr. R. W. Smith-Savile, in the *Burton Observer and Times*, combats the idea that electricity is so much dearer than gas. He says: "I am referred to Mr. Milburn, chairman of one of the two electric lighting companies in Newcastle, who states 'that 6d. per unit is equal to gas at 5s.' (using constant 10 as multiplier). In answer to this, I might state that Councillor Smith, at a recent Council meeting in Barrow (as chairman of the Electric Lighting Committee), stated 'that 5¼d. per unit was equal to gas at 3s.' (using 6·8 as constant). I merely bring his name forward because I consider that he is an equal authority to Mr. Milburn in every respect. I will now give the relative values of the lights in another form. Prof. Robinson found that the Manchester Gasworks (after averaging some 1,000 tons of coal) could produce from 1lb. of coal distilled into 20-c.p. gas, 4·29 cubic feet, or 17·2 candles of light (ordinary first-class burners), and also that 1lb. of coal burnt will give electrical energy sufficient to light for one hour an incandescent lamp with 48 c.p., or, if used in arc lamps, producing 288 candles. A very interesting comparison was recently made in the annual amounts paid per annum per burner for gas and electricity. The average amounts, taking the nine chief towns of this country, paid per gas-burner per annum (gas being reckoned at 3s.) is 9s. I might here mention that I have tried this experiment in my own house. Last year my total gas bills were £3 (at 2s. 9d. per 1,000), or, increasing it to 3s., £3. 5s. 4d. Five rooms were occupied regularly, and the seven burners used in them, therefore, make my average cost per burner 9s. 4d.—a rather interesting corroboration, which anyone possessing his accounts can easily check. We will now see what revenue is received per lamp by the various electrical companies in London. The Metropolitan Electrical Supply Company derived a revenue of 12s. per lamp; the Chelsea Company, 8s. 6d.; the Kensington and Knightsbridge Company, 9s. 2d.; the House-to-House, 11s. 3d.; and the St. James's and Pall Mall, 9s. 6d.; the mean average of 200,000 lamps being 10s. From the above comparison we see that the cost of electricity, even at 7½d. and 8d. per unit (which was the price then charged), is only 1s. more per burner per annum than with gas (at 3s. per 1,000 cubic feet), whilst at the same time we have a light far superior to gas in every respect, the advantages of which are given in with it. In a letter which I received on Monday last, Mr. Preece states 'There can be no question whatever about the correctness of your contention. Electrical energy at 6d. per unit is equivalent in price to gas at 3s. per 1,000. The average over the whole country shows this most conclusively. An ordinary gas-burner consumes an average of 3,000 cubic feet of gas per annum, an ordinary electric lamp absorbs 18 units of electrical energy per annum; as both give the same light it is quite clear that 18 units of electrical energy give the same light as 3,000 cubic feet gas."

Local Government Enquiry at Nottingham.—Mr. Frederick Herbert Tulloch, A.M.I.C.E., an inspector of the Local Government Board, attended at Nottingham on the 11th inst. to hold a local enquiry with regard to the application of the Nottingham Corporation for sanction to borrow £45,000 for the purpose of lighting the town by electricity. The Mayor (Councillor Anderson Brownsword) was present. The Town Clerk (Mr. S. G. Johnson) said he appeared on behalf of the Corporation of Nottingham, with the borough engineer (Mr. A. Brown) and the electrical engineer (Mr. Talbot) He then read the usual formal notices, and proved the powers of the Corporation to apply for the loan, and went on to say that the Corporation had been considerably pressed by the tradesmen of the town to get the electric light. Indeed, the matter had gone so far that several tradesmen had supplied themselves with the electric light from private sources. One or more companies had started here to supply the light, and he supposed those companies would have to be swallowed up by the Corporation when this scheme came into action. The Corporation felt that they could not stand in the way, as some of the shopkeepers had determined to have the light, and the Corporation had consented to the mains being carried under the streets. This showed that there was a demand for the electric light in the town, and the Corporation had at last moved in the matter. They had to excuse themselves for being rather slow in this movement. They had not hurried themselves, because they felt that science was making its best efforts to improve the electric light, and that it was being more and more perfected every day. They had come to the conclusion that the time had arrived when they should supply the light, especially as they could supply it without any loss to the general body of ratepayers. They had obtained powers to ask for this loan under their provisional order, and they had had estimates made as to the cost of supplying the light. The electrical station which it was proposed to set up was one which would not only supply the compulsory area, but would supply an area of three-quarters of a mile from the station—that was a mile and a half across. He should bring before the inspector plans which would show that the supply would comprise a considerable portion of the town. There had been, as the inspector would be aware, considerable controversy as to the best system of electric lighting, and various schemes had been discussed in the Town Council, and eminent authorities had been called in. On the whole, they had determined upon the system called the "low-pressure continuous-current direct supply." They would have to use a high-pressure continuous current, transformable at certain stations, for those consumers who were at a greater distance than those at present anticipated. That was to meet a purely accidental state of things. The constant thing would be a supply at a low pressure. There would be no danger to the public. Every precaution had been taken to prevent the supply being of any danger whatever to buildings or life. They should be able to satisfy him that the requirements of the Board of Trade had been fully complied with, and that they should be able to avoid any possibility of fire or injury to any person dealing with the electricity. Having shown that they had complied with the requirements of the Board of Trade, and received their approval, he should show that they had given the Postmaster-General a month's notice of what they proposed to do. That notice was given on the 1st of March, and was binding on the Postmaster-General, failing to take any notice of it, as showing that he approved of the works. There was no doubt whatever that the Postmaster-General was satisfied that the system proposed would not interfere with the telephones, the telegraphs, or any other system of the Post Office. Moreover, he might say that the Corporation were very much interested in all relating to the Post Office, because its welfare was most important to the prosperity of a commercial town like Nottingham. With regard to the tramways, it was impossible to conceive that they would be in any way affected by what the Corporation proposed to do. Then as to the cost. An estimate had been carefully prepared by Mr. Talbot, the electrical engineer for the Corporation, showing that £48,000 was the total amount required. He did not know that he could say any more. He would just call Mr. Talbot to put in the plans and sections which he had prepared. Mr. Talbot, examined by the Town Clerk, said he was electrical engineer to the Corporation of Nottingham. He produced a plan of the borough of Nottingham on the 6in. scale according to the Ordnance survey. That plan showed the compulsory area, and also the proposed central station. In his opinion £45,000 was a fair sum to ask to borrow for the supply of the compulsory area. The site of the station was a central site for the purpose of lighting the area of the town. The Corporation had some difficulty in getting a site. They advertised, and the site which they had selected was the most suitable with regard to situation and price that they could get In the compulsory area there was a large number of places of business likely to require electricity—indeed, most of the places in the town likely to require it were situated within that area. The proposed system was the low pressure, 200 volts, three-wire system. Eventually they might have a high-pressure continuous-current system, but they did not require that within the central radius at present. They would provide a constant supply of electricity to consumers day and night. Where they required high pressure that would be when they began to supply outside the central radius, and it would have to be taken there on smaller wires. He had served notice on the Post Office authorities, and they had not stated any objection to the scheme. He had also served notice on the tramways company, and they had not stated any objection. The Board of Trade had raised no objection. The proposed system was entirely free from danger. He produced plans and sections. Colonel Thackeray asked the town clerk whether any money and, if so, what amount had already been paid by the Corporation of Nottingham on account of the electric light? The Town Clerk said there were the fees to Mr. Preece and Dr. John Hopkinson, and they had paid £11,000 for the land for a site for the station. He did not know of anything else that they had paid About 200 guineas had been paid in fees. Colonel Thackeray said he came there as the representative of a firm which was one of the largest consumers of gas in the borough. He referred to the firm of J. L. Thackeray and Sons. They had great complaints to make with regard to the quality of the gas and to the supply, he meant with regard to the illuminating power, and also with regard to the variation in the supply, which was very detrimental to them in their manufacture—the manufacture of cotton. He quite agreed with the town clerk that it was desirable that the electric light should be introduced into Nottingham, but he did not agree with the town clerk that the electric light should be in the hands of the Corporation. Had the Corporation managed the gas undertaking well, then he thought it would be desirable that the Corporation should have the control of the electric light. Another point that he wanted to mention was that he believed that the debt on the gas account was very large, and in comparison the reserve fund was something infinitesimal. (The Town Clerk: The reserve fund is about £100,000.) Colonel Thackeray went on to say that he could not give the actual figures of the debt, but he knew it was very large, and during the last 20 years large sums had been taken from the so-called gas profits to alleviate the rates; in other words, the large consumers of gas, and their workpeople, had to be taxed most heavily for the benefit of the general population. He maintained that if the Corporation took anything from the gas profits they should put it to the reserve fund. Had that been done the Corporation would not now be in the position of having to ask the Local Government Board to sanction this loan. Had they had a reserve they might have taken a certain amount of that in order to introduce the electric light. Then, again, the borrowings of the town altogether, he thought, amounted to over five millions of money, and that debt had been piled up in the last 30 years. He could not say what the assets were, but those were the liabilities. There was a very strong feeling in the town against these continuous borrowings, and on that account he begged to object to this scheme. The Town Clerk did not think that the chairman of the Gas Committee would agree with Colonel Thackeray in his idea of using some of the reserve fund to introduce the electric light. That reserve fund was a most important fund, because whatever expenses with regard to the gas undertaking might be incurred they had otherwise no means whatever of meeting such expenses. He must say with regard to the management of the gas undertaking that he thought it was one thing of which the Corporation was rather proud. He thought that their management of the gas undertaking had been of great service to the town. Colonel Thackeray had raised a question which they could not discuss there—namely, how far the Corporation would use its profits to reduce the rates. They were in trade as manufacturers of gas, and it was an open question how they would use their profits, if there were any. With regard to the electric light, he believed they would be exactly in the same position. The electric lighting order put them in the same position, and they could use the profits, if any, for the purpose of reducing the rates. He should think that there were at least 20 towns with a much higher debt per head than Nottingham. Without being in any way disrespectful, he thought that Colonel Thackeray's observations that morning were quite beside the question. They were there to ask for the electric light, and they had no fund to use for the purpose. Colonel Thackeray said he must draw attention to the fact that the gas reserve fund, which, he fully agreed with the town clerk, was most important to the town, had not been added to for 15 or 16 years. He maintained that if the gas had been well managed, and if direct taxation had been adopted instead of indirect taxation, that gas debt would have been extinct now, and it would have been quite possible and feasible, besides being good policy, to have taken, under those circumstances, part of the reserve fund for the purpose of the electric light, and that that policy would have been agreeable to the general body of ratepayers of the town. The enquiry then terminated.

PROVISIONAL PATENTS, 1893.

May 8.

9136. **An improved clutching device for use in electric arc lamps.** Edward James Paterson and Joseph Foxcroft, European Works, Pownall-road, Dalston.

9149. **Improvements in telephony.** Charles Adams-Randall, 1, The Avenue, Bedford-park, London.

9171. **Improvements in electrically-illuminated gun-sights for use at night.** H. de T. Phillips, The Castle, Dover.

9184. **An improvement in arc electric lamps.** Edward Carstensin de Segundo, 28, Southampton-buildings, Chancery-lane, London.

9204. **Improvements in electrical measuring and recording instruments.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

May 9.

9262. **Electric meters.** Oscar Ericsson, 77, Colmore-row, Birmingham. (Complete specification.)

9281. **New apparatus for counting telephonic conversations.** Robert Howe Gould, 37, Chancery-lane, London.

9295. **An improved electrolytic apparatus.** Thomas Craney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9296. **Improvements in apparatus for the electrolysis of salt.** Thomas Craney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9297. **An improved electrolytic apparatus.** Thomas Craney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9302. **Improvements in contacts for underground electric railways.** William Quishenberry Prewitt, 322, High Holborn, London. (Complete specification.)

9304. **Improvements in electric lamps.** Alfred Julius Boult, 323, High Holborn, London. (John Waring, United States.) (Complete specification.)

9308. **Improvements in machines for equalising electrical currents without a current inverter.** Friedrich Vogel, 323, High Holborn, London.

May 10.

358. **Improvements in connections for electric lighting and like purposes.** Gustav Binswanger, 11, Furnival-street, Holborn, London. (Complete specification.)

9397. **Improved means for taking or transmitting power from electromotors.** Charles Riley Garrard and Thomas William Blumfield, 37, Chancery-lane, London.

9380. **Improvements relating to automatic breaking of current circuit for electric lamps or other devices.** Reginald Haddan, 18, Buckingham-street, Strand, London. (A. Reisinger, Germany.)

May 11.

9473. **An improved electrical device for curative purposes.** George Russell, 37, Chancery-lane, London.

9478. **Improvements in insulators for electric wires.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Hartmann and Braun, Germany.)

May 12.

9486. **Improvements in stands for electromotors for dental and other purposes.** William Greenhalgh and Samuel Wells Cuttriss, The Elmwood Electrical Works, Camp-road, Leeds.

9529. **Improvements in or relating to the distribution of electricity for electric lighting or other purposes.** John Alexander McMullen, 124, Chancery-lane, London.

9552. **Improvements in or relating to microphones or telephones.** Theodor Paetzold, 18, Buckingham-street, Strand, London. (Complete specification.)

9557. **Improvements in dynamo-electric machines and electric motors.** Herbert Napier Prentice, 47, Lincoln's-inn-fields, London.

May 13.

9627. **Improved means for supporting porcelain or other imitation candles on electric-light fittings.** Harold Faraday, 11, Southampton-buildings, Chancery-lane, London.

9630. **Improvements in and relating to electric arc lamps.** Ladislas de Kostecki and André Adolphe Pical, 45, Southampton-buildings, Chancery-lane, London.

9638. **Central-office apparatus and circuits for telephone exchanges.** Edward Julius Hall, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103, 13th October, 1892, being date of application in United States.)

9639. **Trunk-line signalling apparatus and circuit for telephone exchanges.** Edward Julius Hall, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103. 13th October, 1892, being date of application in United States.)

9640. **Electrical signalling apparatus and circuits.** Edward Julius Hall and Frank Albert Pickernell, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103, 13th October, 1892, being date of application in United States.)

9641. **Busy-signal for telephone circuits.** Edward Julius Hall and Frank Albert Pickernell, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103, 13th October, 1892, being date of application in United States.)

SPECIFICATIONS PUBLISHED.

1892.

7718. **Electric arc lamps.** Akester.
9515. **Ammeters and voltmeters.** Perry and Holland.
9678. **Electricity distribution.** Edgar and Munro.
10823. **Telegraphic, etc., insulators.** Buller.
11525. **Electric cables.** Hardingham. (Felten and Guilleaume.)
17462. **Earthenware electric switches, etc.** Meir.
23113. **Electric alternating currents.** Von Dolivo-Dobrowolsky and others.

1893.

1840. **Electric railway signalling.** Dean.
2674. **Electric switches and door-locks.** Holcombe.
4356. **Welding metals electrically.** Thompson. (Coffin.)
4746. **Incandescent electric lamps.** Imray. (Bottom.)
5340. **Electric motors.** Lundell and Johnson.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	6¼ 4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Lead Pipes.—At Hamilton, Canada, the lead pipes near the electric railway power-house are found to be rapidly eaten in holes.

Gilgit Telegraph Line.—The new telegraph line to Kashmir, from Srinagar to Gilgit, is 12,000ft. high at the summit of the Tragbal Pass.

Tasmanian Exhibition. — Buildings are being erected for an international exhibition at Hobarts Town, Tasmania, for the season 1893-4.

Siam Telegraphs.—The interruptions in the Siamese telegraph service have been so frequent that the merchants have met to petition the Foreign Minister for better service.

Electric Advertising.—A new dodge in advertising is to be seen at a provision dealer's in Electric-avenue, Brixton, in the shape of an electric man, seated in a chair, presumably ready to be executed.

Alternating-Current Motor.—A small Joel alternating-current motor has been on view in Portman-place, W., this week, working on the ordinary alternating circuits. The motor is about ¼ h.p., and drives a lathe. It is intended to replace a gas-engine, and runs very satisfactorily.

Technical School for Halifax.—The foundation-stone was laid on Wednesday by Mr. William Hunter, Master of the Clothworkers' Company, London, of a Technical School for Halifax. The school is being built by public subscription. The total cost is expected to be a little over £20,000.

British Museum.—Owing to the inconvenience felt by the flickering and shadows from the arc lights at the British Museum reading-room, it is intended to introduce separate incandescent lamps, placed at the readers' desks. The proposed alteration is viewed with much favour by the frequenters of the reading-room.

Progress.—We have received from M Julius Springer the fifth yearly edition of "Fortschritte der Electrotechnik"—progress in electrical science. Besides a digest of the literature of the period, particulars are given of the progress achieved by the German Post Office, Messrs. Siemens and Halske, Schuckerts, and the Allgemeine Company.

Telephones for Casuals.—The Salford Board of Guardians have agreed to enter into an arrangement by which vacant accommodation for casuals at Manchester, Chorlton, Prestwich, and Salford could be made available for casuals who could not be accommodated at other wards for want of room. The wards are to be connected together by telephone.

Personal.—The directors of the West India and Panama Telegraph Company have just selected Mr. Andrew Gray to be assistant electrician on board their telegraph steamer, the s.s. "Grappler." Mr. Gray gained the diploma of the Glasgow and West of Scotland Technical College in electrical engineering last year, and he has acted as laboratory assistant to Prof. Jamieson during the past session.

Yorkshire Dynamos.—We have received a catalogue of electric lighting plant from Messrs. Rosling and Matthews, Trafalgar Works, Bradford. The firm's make of dynamo, named the "Yorkshire" dynamo, is illustrated; an overtype two-pole machine of good construction. Switchboards, motors, and electric mining machinery are also shown, and a long list of users of the dynamos in the North of England is given.

Electric Launches for China.—It seems that there is an opening for electric launches in China. The United States Consul, Mr. Fowler, in a recent report calls attention to the immense field for power launches on the great canals of China, and gives the following as suitable dimensions: Length, 38ft.; breadth, 6ft. 10in.; height, keel to rail, 3ft.; rail to top of house, 2ft. 9in. The Taotai, or Governor, of the Ningpo district has asked for particulars of such launches.

City Bridge Lighting.—In response to an application made by the City of London Electric Lighting Company to the City Corporation in July of last year, they decided on the 17th inst. "That it is not desirable to light the bridges by electricity." As the County Council is promoting a Bill to light the remaining City bridges by electricity, we shall probably be favoured once more with the accustomed spectacle of the City Corporation bringing up the rear in the march of progress.

Tramways and Telephones.—A meeting of the council of the Municipal Corporations Association was held last week at the Westminster Palace Hotel, Sir Albert Rollit, M.P., in the chair. The action of the telephone companies in regard to tramways worked by electricity was discussed, and a resolution, proposed by the Town Clerk of Manchester, and seconded and supported by the Mayor and Town Clerk of Leeds, was passed declaring that the matter was of such importance that it should be dealt with on Thursday, June 1.

Electrolytic Painting.—Hitherto, if copper or other metal is to be deposited electrically a bath of solution has been needed. Now this is all changed, and a ship's hull can be plated as easily as a spoon or teapot. Instead of a bath we are to have insoluble salts, ground to a fine powder and mixed with water. This is painted on the metal to be plated by a fine wire brush, to which one pole of a dynamo conductor is attached—the other pole being connected to a plate. Not only pure metal, but all sorts of alloys can be used. Aluminium can be so plated, it is said, with silver or gold.

Telephones at Stockholm.—Of all the large cities Stockholm is noted as possessing the most complete telephone installation, cheap, well-managed, and ubiquitous. We have before us a photograph of the telephone exchange, showing the arrangement on the roof for massing the telephone wires. This is not by any means an uncouth superstructure. It is well proportioned, rising above the roof like a square filigree tower, the corners turretted gracefully, and each corner bearing a thin flagstaff. In the photograph the telephone exchange takes an almost cathedral-like look, due to the gracefulness of the roof turrets. The interior arrangements are equally handsome and well considered. The photograph is by Gosta Florman, 28A, Regeringsgatan, Stockholm.

Canadian Niagara.—Work is rapidly going on, it appears, for utilising Niagara on the Canadian side for an electric railway. The tunnel is 600ft. long and 8ft. by 10ft. The wheel pits are 80ft. deep, and large enough for three horizontal turbines of 1,000 h.p. each. The power-house just above the falls and opposite the foot of Cedar Island will be 100ft. long by 60ft. wide, and at first will contain three dynamos of 250 h.p. each. These, as well as two others at the Queenston steam power-house, will be constructed by the Canada General Electric Company, of Toronto. In the latter power-house will be two 150-h.p. Wheelock engines, with dynamos of 200 kilowatts capacity. These will be used to drive the electric railway up the mountain 1½ miles, at 250ft. rise to the mile. The line is to be opened this month.

World's Fair.—When President Cleveland opened the World's Fair at Chicago, before thousands of spectators, the immense machinery was started by a simple touch on an electric key. Two different methods were employed that the impulse sent by the President's finger should actually start the mechanism. At the engine-house, a coiled spring, attached to an axle and flywheel, was kept from moving the steam-valve by a trigger; when the key was touched the trigger was attracted, the spring acted and turned the valve, admitting steam and setting the enormous engine at work. At the pumping station the armature of a powerful magnet controlled the valve of a miniature steam-chest, moving a piston, which threw the throttle of the pump open. Dynamos revolved, fountains played, flags were unfurled—the Great Fair was open!

Niagara Blue Prints.—The Westinghouse Company have made a sensational charge against the General Electric Company of America for conspiracy and fraud in stealing blue prints and other technical plans. The latter company laugh at the charge, as it is impossible, they say, for any firm to keep engineering prints in secure keeping. But the charge is that payment was made for a young engineer to join the Westinghouse works and supply private information and plans immediately. The trouble seems to be over the Niagara job, a plum that is anxiously looked for. It is urged that the amended plans of the General Company are very like indeed to those of Westinghouse; but, on the other hand, the Cataract Company aver these two plans resemble one another no more than do those submitted from Europe, the condition giving rise to like plans for the machinery.

High-Level Bridge for Liverpool.—Messrs. John J. Webster, C.E., of Victoria-street, Westminster, and Mr. John T. Wood, C.E., of Cook-street, Liverpool, have drawn up and issued a detailed scheme for a high-level bridge over the Mersey, rivalling in magnitude the great bridge at New York. The bridge is designed on the arch suspension principle, and is to consist of three spans, each of 1,150ft., the centre span being about 150ft. above the river at high water. The plan admits of a roadway 40ft. in width for vehicular traffic, and a footway of 7ft. 6in. on either side. Above is a railway for electric tramcars. Exclusive of this tramway line, the cost is estimated at £1,730,000. The promoters estimate that the fact of the bridge being available night and day, whatever the state of weather and tide, would lead to a great increase of traffic, and that the income would be not less than £165,000 a year.

Workshop Motors.—M. Sartiaux, who has charge of the workshops of one of the large French railways, having tested a large number of machine tools driven by electricity, gives the following interesting list of currents required at 115 to 118 volts:

	Running empty.		Loaded.	
Lathe, medium	6	amperes	10 to 12	amperes
„ small	3·5	„	5 to 6	„
„ jeweller's	2·5	„	4	„
„ small polishing	3	„	5	„
Drill press, small......	2·5	„	4	„
„ medium...	4	„	6	„
„ large radial	3	„	7	„
Milling machine	11·4	„	15	„
Grindstone	4	„	7	„
Band-saw...............	8	„	9·5	„
Ventilator	7	„	8	„
Crusher and mixer...	10	„	11	„

The current used in the shop from a central station costs 4·18f. per day, or with motor expenses 5·18f. Formerly the gas-engine used cost 13f. per day, besides the attendant's wages.

Burglar Alarms.—A neat and simple burglar alarm contact has been brought to our office by Mr. Ben. Townley, who has registered the pattern. Two spring contacts are separated by a thin wooden wedge; to this wedge is attached a length of whipcord, and this, again, can be fastened to sash, blind, door, or what not, while the contacts are screwed to the fixed sash or jamb. Any slight push withdraws the wedge and starts the bell, which may, of course, be outside the house to call the police or in the occupier's bedroom. A set of four enterprising burglars were disturbed a little while ago by this means at the house of Mr. Hull King, of Newstead-road, Lee. The burglars had broken into the kitchen and regaled themselves with bread and cheese and wine; but on attending to their business, opening the hall door rang a bell, and the occupier's party cautiously descended to see the housebreakers clearing over the wall without further booty. A 10-hole indicator has been now put up to show the exact room in which the alarm rings. Mr. Townley is busy developing a number of such useful little inventions at Nelson-street, Greenwich, and is placing these burglar contacts on the electric bell market at favourable rates.

Use of Electricity in Medicine.—Herr Emil Braunschweig's Electrotechnisches Institut at Frankfort-on-Main seems to deal mostly with the application of electricity to medical purposes; in fact, it is of the nature of a supply institution of electro-medical appliances, and we have received a catalogue showing some very useful forms of such apparatus. Accumulator batteries seem to have become favourites for supply of current, though Gulcher thermopiles run them close for convenience of use—a thermopile giving 3·5 volts and three amperes, costing 160 marks (or shillings) at first, and ½d. an hour for maintenance, would seem an ideal supply for the laboratory of an electrical medico. Some new types of head springs for laryngscope work are convenient, and cautery needles of several dozen kinds valuable in their way. Induction coils of excellent make are shown, and a transformer for use on an ordinary town circuit. A rather special feature seems to be the construction of stands for holding electrodes which can be applied on the head, neck, or other parts of the body, and pictures are shown of the use of a Wimshurst machine in this way. Accurate meters reading milliamperes are included in the list of apparatus.

Gas Power for Electric Lighting.—In the search for economy of electric lighting, sufficient attention has not been paid, we feel sure, to the production of electrical energy by large gas-engines driven by cheap heating gas. In the central station at Morecambe gas-engines have been used with good effect, and it would be interesting if the directors or engineers of this installation would keep before the electrical world the results of their experience. An installation which will be worthy of attention also in this direction is that for lighting the new railway station at Leicester. The Midland Railway Company have ordered a set of the Dowson gas plant to work, burning ordinary gas coke. The power generated will be about 200 b.h.p., and the engines will be of the Crossley make. This installation, undertaken by a powerful railway company, serves as type of an increasing number of gas-engine electric light installations. The advantages are many—the first cost is not excessive, cost of running is kept proportionate to the hours of running, and by the use of gas coke smoke is reduced to a minimum. On the Continent eminent engineers have been studying practically and with success the problem of driving large engines by gas, and direct-coupled dynamos and gas-engines driven by heating gas are at work. Instances are not wanting also in America, and the above two notable instances in England will serve to direct attention to a useful and convenient form of electric installation.

Tommasi Accumulator.—The most recent type of accumulator produced by M. Tommasi has electrodes enclosed in a rigid or elastic insulating sheath of celluloid, ebonite, indiarubber, guttapercha, etc., pierced with numerous small holes. In the centre is a lead core acting as conductor, and in contact with each of its faces is a coating of lead oxide kept in shape by the perforated sheath. This arrangement doubles the capacity for equal weight. The liquid is five or six volumes of water to one of sulphuric acid at 66deg. chemically pure. Commercial acid is not exactly this strength; the mixture should be verified—20deg. to 25deg. Baumé. It should be mixed in a vessel not attacked by the acid, and when cool poured in till the electrodes are submerged 1cm. The charge can take place at five to six amperes per kilogramme. The full charge can be seen by bubbling or tested by acidometer; the density increases from 1·15 to 1·20. The discharge varies from one to four amperes per kilogramme, and should be stopped when the potential decreases to 1·7 volts per cell. The Tommasi accumulators can stand without inconvenience discharges of six to eight amperes per kilo in cases of variable discharge, even over a certain time. The boxes are of hard wood, rendered watertight by a coating of celluloid. They stand any ordinary shocks. They are covered and fitted with a window. The cells require little attention, not being subject to fall of active material at short circuit. They should be placed in a dry place on oil insulators. To give an idea of the great capacity of the Tommasi cell, the following comparison is given:

System.	Ampere-hours per kilogramme of electrode.
Tudor	3·52
Hagen	3·74
Oerlikon	6·16
Tommasi (normal)	25·0
" at 3 to 4 amperes per kilogramme of electrode	20·0

The Telephone and the Medical Profession.—A great row has been created in Sheffield by the sudden cutting off of Dr. Dyson, one of their noted doctors, from the exchange. It seems that Dr. Dyson subscribed to the old exchange, and when the National Telephone Company took it over a new agreement was drawn up. Dr. Dyson objected to the clause that there was no undertaking on the part of the company to repair any damage in the case of wayleaves. His roof was several times damaged, and the company, though written to, did not attend to the repairs. Last week the manager rang him up, asked if he would sign, and on being told "Not until the wayleaves clause was settled," promptly cut him off, to the danger of many of his patients and the inconvenience of the whole medical profession of Sheffield. A meeting of doctors was called, and Mr. Arthur Jackson moved, "That this meeting of the members of the medical profession in Sheffield in view of the action taken by the National Telephone Company in removing their instrument from Dr. Dyson's house in Westbourne-road at half-an-hour's notice in consequence of a dispute as to the terms of the new agreement between the company and their subscribers, and in view of the serious consequences dependent upon such action by the company in case of emergency and in the general work of the profession, protests in the strongest possible manner against the possibility of such action being taken on the part of the company with regard to any member of the profession in the future for any other cause than that of failure to pay their annual subscription." The resolution was carried unanimously. Mr. Browning moved, "That Dr. Dyson, Mr. S. Snell, and Dr. J. W. Martin be a sub-committee to look into and consider the agreement, and report to a future meeting of the profession." He said he should like to know whether it was desirable to open up the whole question and consider the advisability of a competing telephone company. The resolution was carried. Mr. Jackson advised those who had not signed the agreement to refrain from doing so until the sub-committee had reported.

Electric Root Grubber.—Grubbing is the term for pulling up tree-stumps by the roots, and this operation is now being accomplished at Otford, in Kent, by electricity. The inventor of the electric grubber is Mr. Freeman, whose Invicta Works are very pleasantly situated at Otford, on the River Darenth, the water of which in passing yields the necessary power for driving the generating plant, as well as the many other machines connected with his business. This business is a varied one, as the proprietor says "there are few jobs turned away, and the more out of the way they are, the better we like them, as yielding greater interest and profit." The works are unpretentious, Mr. Freeman having taken them as an old, ruinous, and dilapidated flour mill, simply on account of the water power, which is now being turned to such interesting and profitable use. The lighting machine is a small Gramme of the old type, installed some four or five years since, during which time it has done good service. A second generator is used for experiments in electrical ploughing, threshing, etc. Mr. Freeman is an enthusiast in these matters, and thinks electric agriculture has a great future before it, as it will undoubtedly prove itself to be more efficient and economical than either horse or steam power as at present applied, saving the carting of all coal and water, and where water power can be turned to account being very much less for running expenses. The third dynamo, giving 15 to 19 kilowatts, is used for generating current for supplying the grubbing apparatus at the top of the Polhill, some two miles distant. It requires about 25 h.p. to drive it at its maximum, although not more than one-third of this is usually required. The current is taken by overhead wires on telegraph poles to the motor on the grubber carriage. At the top of the hill several acres have been already grubbed. The ground is being cleared for the purpose of constructing one of a series of large forts for the protection of London. The motor drives, by means of belting and suitable gearing, a capstan upon which is coiled a few turns of a very strong steel-wire rope. A heavy chain is attached to the tree roots, and as the motor is set to work and the rope exerts its force, the roots come up quietly one after the other. The installation is an interesting example of the application of electric power to country work.

Electric Light Plant.—A firm that is rapidly taking front rank in manufacture of electric light engines is that of Messrs. G. E. Belliss and Co., of Birmingham, who now send us a new edition of their catalogue. They give on the first page an imposing list of ships supplied for the British navy, with electric light machinery and an illustration of three sets of ship plant for the United States Government of 200, 300, and 400 ampere capacity at 80 volts and 320 revolutions. A single-cylinder dynamo engine is largely used for small installations, say, 5 h.p. to 30 h.p. at 80lb. pressure. The usual type for large installations—that is, 8 to 32 kilowatts—is a double-cylinder engine, direct coupled to dynamo. Central-valve engines with expansion governor are supplied for still larger sets, and an illustration is shown of one out of eight sets supplied by the firm to the new Cunard mail steamers "Campania" and "Lucania"; these were designed to develop 65 b.h.p., at 275 revolutions. They represent the latest practice for lighting of large steamers, and are equally well adapted for central stations and other large installations. A speciality is made of the Belliss double-acting high-speed engine, 10 h.p. to 50 h.p., about

500 revolutions per minute. These engines are very silent, and are also made enclosed. Air-compressing engines is a special branch of the firm's work, and a gas compressor engine for compressing coal-gas for train-lighting purposes is shown. Various pumps and air-circulating engines are such as would be required in central installations. A vertical surface condenser, suitable for use with any kind of engine, forms a convenient combination where additional economy is required in electric light engines, or the water supply for the boiler is bad. Messrs. Belliss are also giving attention to the manufacture of electric fans, and have in course of construction a number of large ventilating fans arranged for quiet and continuous running. They are busily engaged in marine work, and a photograph is given of H.M. ship "Karrakatta"—a torpedo gunboat—the whole machinery of which was designed, made, and fitted by Messrs. Belliss. The catalogue concludes with description and illustration of several types of modern boilers made by the firm, amongst others, a set of fine Lancashire multitubular boilers for the pumping station at the East and West India Docks, Tilbury.

Rival Illuminants.—It is somewhat instructive to observe the different complexion that the progress of events has thrown on the attitude of the gas towards the electric industry. At one time, not so long ago, gas engineers regarded their electrical *confrères* with a feeling somewhat akin to ridicule. Nor was the cause of this far to seek. This "new illuminant" threatened to be a rival that must be reckoned with, but its exponents were, as a rule, men who had not been through the mill of practical experience of mechanical engineering, and were pioneering a new industry without a knowledge of this branch of their subject, which has since proved to be, if anything, the more important. What is the position to-day? Gas engineers are realising that the central electric lighting station has come to stay. An appreciation of the difficulties to be overcome, and the rapid development of a new industry, has brought to the ranks of electrical engineering men with a thorough grasp of their subject, who, with the light of past failures and their own engineering experience to guide them, have been able to avoid those pitfalls which brought the pioneers to grief and the industry into disrepute. The gas industry has now to deal with trained and skilled electrical engineers determined to make their work a success, and with the necessary knowledge to do it. Central stations are springing up in every large town, and gas engineers have perforce to recognise the importance of the rivalry. Perhaps the most significant sign of the times is the number of firms interested in the gas industry who have opened an electrical department. There are few towns of any size who have not discussed the question of electric lighting, and the contracts that have already been given evidence that the amount of capital invested in the industry is rapidly on the increase. Can gas engineers participate in the good time that is coming? As far as house-wiring and general installation work is concerned, they have done and are doing a large share of the work; but for central-station contracts we do not think that, for the present at any rate, their competition need be reckoned with. There is yet the question of the dual supply of gas and electric light to be fought out by the gas companies. In towns owning their own gasworks the Gas Committee has in several cases become the "Gas and Electricity Committee," and the rival illuminants work in harmony. Whether they can be made to do so with the gas companies, or whether the companies care to try to attempt it, remains to be seen, although abroad it has been successfully done in many cases. The most rational method is for the two industries to work hand-in-hand. Experience shows that in reality a central station is the best friend a gas company can have. In every case the consumption of gas has increased, where electricity and gas are in competition, the demand for a better light being at once evident.

An Elevated Railway in Naples.—A remarkable scheme, which may be regarded as unique, has been laid before the Syndic and Town Council of Naples for the construction of an elevated railway in that town, and a concession for the carrying out of which has recently been granted. The project is due to Signor Adolfo Avena, 80, Rione Amedeo Villimo Esti, Naples, and with whom Signor Fantoni, of the Galleria Umberto I., is concerned in the matter. The railway will place the handsome and populous centre of the town near to the Via Roma—in fact, the centre of Neapolitan life and business—in communication with the Corso Vittorio Emmanuele, the San Martino Hill, and the elevated part of the town known as the new Rione del Vomero. At present access to these districts is difficult owing to the narrow, winding little streets, many of which are only passable for pedestrians. The line will be carried on two metallic viaducts, one arranged at a higher level than the other, and each having a double way. Each passage will be independent of the other, one forming a course for electric cars and the other being reserved exclusively for foot passengers. The first viaduct, of a length of 1,180ft., will commence in a masonry tower 325ft. high, in the Via Roma, opposite the Via S. Brigida, and will terminate in the base of a second metallic tower 490ft. high, to be built in the Cariati Gardens in the Corso Vittorio Emmanuele. The second viaduct, starting out of this metallic tower a certain distance below its summit, will pass over the San Martino Hill and terminate on the level at the new Rione del Vomero. Thus the metallic tower will form the connecting link between the two viaducts, which will be carried on 11 pyramidical metal columns or towers having masonry foundations. Three of these will be erected on the San Martino Hill, and the remainder will be built in and will project through the roofs of buildings to be acquired for the purpose. The arrangement of the viaducts will not in any way interfere with the actual conditions of the streets. Each of the two towers will contain staircases for ascents and descents, and also two platform lifts. The electric cars, after running along either viaduct, will be automatically placed upon the lifts for hoisting or lowering passengers, who, having once taken a seat in the car at one of the termini, will be conveyed to the other end of the line in eight minutes without the necessity of changing seats. A small charge will be made during the day to foot passengers along what would be "the most fantastic passage in the world," whilst during the night the way would be free. With three electric cars, each capable of accommodating 96 persons, it will be possible with a 10 minutes' service to carry about 22,000 persons in a day of 19 hours. The generating stations for both lighting and power will be situated in Via Roma and at the new Rione del Vomero. Restaurants and observatories are to be arranged on each tower. Signor Avena estimates at £196,000 the total cost of carrying out the undertaking, including the acquisition of property, masonry work, constructive iron and steel, machinery, and provision (£18,700) for contingencies. An elaborate calculation as to the present movement of traffic between the districts to be served by this railway shows that an average daily sale of 14,000 tickets at a mean of 2d. each may be expected. This would bring in an annual revenue of over £42,000, which, after deducting all working expenses, taxes, maintenance, and providing for redemption, would yield a net return of over 18 per cent. on the invested capital.

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 502.)

First Design.—This shall be of the long shell type having a square core. This form of transformer is largely used both on the Continent and in England, but the different makers use various methods of building up the core and of winding the copper circuits. We will assume that a 4in. core is required, and that the general outline of the iron circuit is that shown in Fig. 6. The gross area of the section of the core is then 15·4 square inches, and allowing for 85 per cent. of the space being taken up by the iron, this gives a core area of 13·1 square inches, or 84·5 square centimetres. Adding up the lengths of the various parts we get a total of 48in., which gives a volume of 630 cubic inches of iron, weighing 176lb.

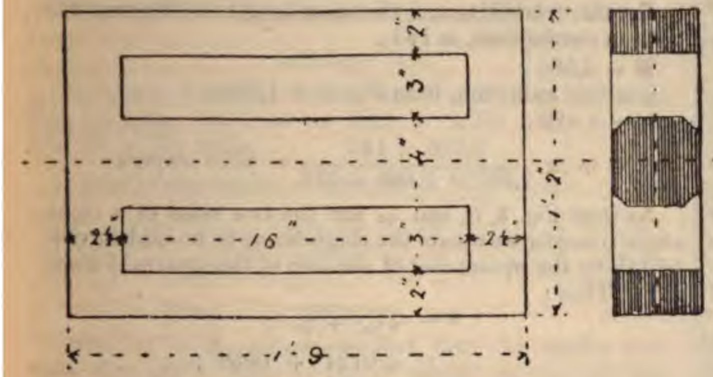


FIG. 6.

Now the total iron loss was to be 150 watts, so that the loss in hysteresis and Foucault currents for 1lb. of iron is $\frac{150}{176} = \cdot 85$ watt. From the curve, Fig. 4, it will be seen that this corresponds to an induction of about 3,600 lines per square centimetre.

Hence the total flux F = 3,600 × 84·5.
= 304,000.

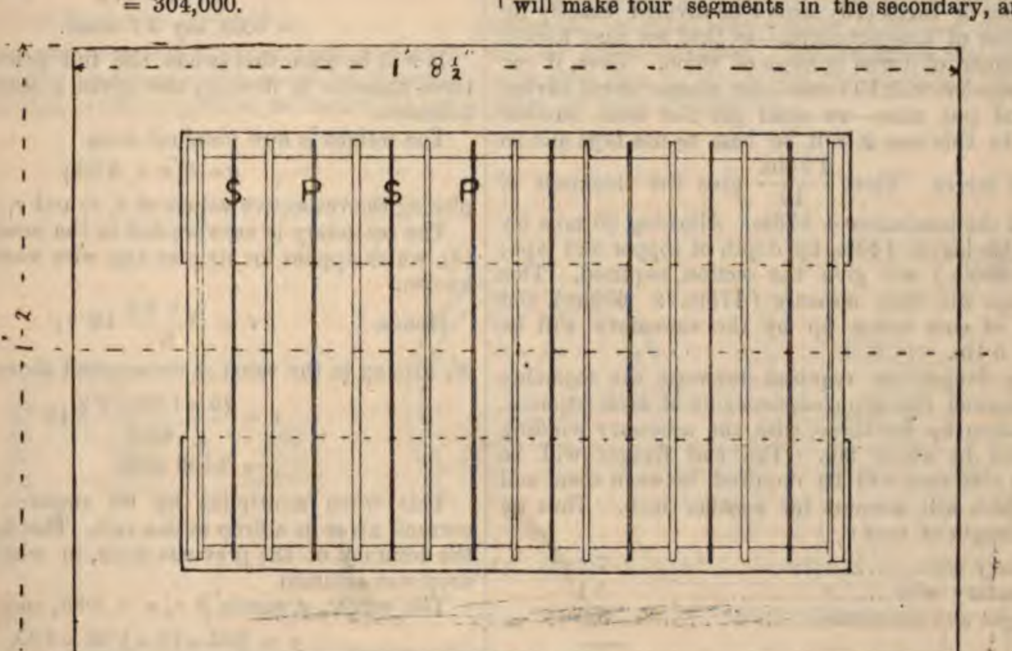


FIG. 8.

From this we can now by aid of (1) determine the number of turns required in both windings. For the secondary we have—

$$e_2 = 4 \cdot 45\,F\,\tau_2\,n\,10^{-8}; \text{ and in this case}$$

$$e_2 = 102,\ F = 304{,}000,\ n = 100;$$

$$\therefore \tau_2 = \frac{102}{4 \cdot 45 \times 100 \times 304{,}000} \times 10^8 = 75 \cdot 5.$$

An even number of turns must be used for convenience, and hence 76 will be nearest to the number required. It is always well to calculate the secondary first, and to obtain an even number of turns in it, as it is not well to introduce half and quarter turns in either of the windings. We get number of turns on the primary from the ratio of the voltages.

Thus
$$\frac{\tau_1}{\tau_2} = \frac{e_1}{e_2} = \frac{2{,}000}{102},$$

$$\therefore \tau_1 = \frac{76 \times 2{,}000}{102} = 1{,}490.$$

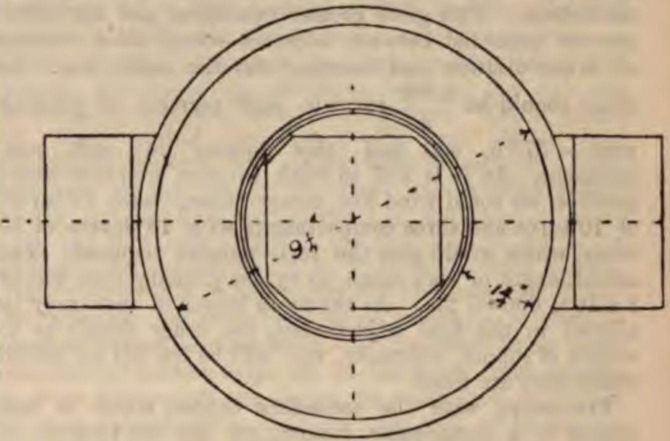


FIG. 7.

The next step to be considered is the arrangement of the copper circuit. It is found that if the coils are wound separately and placed one at either end of the core, as shown in Fig. 1, a large magnetic leakage takes place at full load. This causes a drop in the voltage, which is very objectionable, as explained above. There are several methods of obviating this defect, and one is to split the two windings into sections, which are placed alternately along the core, Fig. 8. In this way the demagnetising effect of the secondary is not collected to one part of the core, and by the subdivision the magnetic leakage is reduced to reasonable limits. So in this transformer we will make four segments in the secondary, and interleave them with four of primary wire. The necessary radial insulation will be about that shown in Fig. 7, and the depth of winding we may assume to be 1¾in. The mean circumference of the winding will then be 1·97ft. = π.

Designing the primary first and using round wire for it, we get from (4)

$$d = \sqrt{\frac{i\,\tau_1\,\pi\,11 \cdot 75}{\theta}}\,10^{-8},$$

Here i = 3 amperes ;
τ_1 = 1,490 turns ;
π = 1·97ft. θ = 20 volts = 1 per cent. ;
l = 2,940ft.;

$$\therefore d=\sqrt{\frac{3\times 1{,}570\times 1{\cdot}97\times 11{\cdot}75}{20}}\,10^{-3};$$
$$=\cdot 072.$$

Thus, wire 72 mils diameter will give the 1 per cent. loss at full load. The insulation and clearance required in winding would bring the pitch of the wire up to 90 mils. Dividing the depth of winding by this, we get $\frac{1\cdot 75}{\cdot 09}$ = 19·4 as the number of layers which could be got in. In each segment of winding it is well to have a subdivision, so that each half can be wound separately from the bottom. This gives greater insulation, and less difference of potential between adjacent wires, than winding all in one division and bringing out the inside end. So there should be $\frac{1{,}490}{4}$ turns to each segment of primary wire = 372·5, and half this number in each compartment. As it is well to work to even numbers where possible, we could wind five compartments with 19 layers of 10 turns and three compartments with 18 layers of 10 turns, which would give the total number required. The actual length of core taken up by the primary wire will be $8\times 10\times \cdot 090 = 7\cdot 2$in. As the mean length of turn may be altered in the final adjustments, the other details as to weight of copper, resistance, etc., will be left till the actual dimensions are fixed.

Proceeding with the secondary copper, which is best wound in a rectangular section, we use the formulæ in group 3.

The sections, S, in square inches $=\frac{i_2\,\tau_2\,\pi\,9\cdot 2}{\theta}10^{-6}$.

In this case i_2 = 60 amperes ;
τ_2 = 76 ;
θ = 1, and π = 1·97 as before ;
so that l = 150ft.

$$\therefore \mathrm{S}=\frac{60\times 76\times 1\cdot 97\times 9\cdot 2}{1}\times 10^{-6}=\cdot 083 \text{ sq. in.}$$

The number of turns (76) cannot be divided exactly by 8—the number of compartments—so that we must have a different number of turns in some of them. Thus, if we wind each segment with 19 turns—one compartment having 10 turns and one nine—we shall get the total number correctly. In this case it will be best to use tape and to allow for 10 layers. Thus, $\frac{1\cdot 75\text{in.}}{10}$ give the thickness of the tape and the insulation = ·175in. Allowing 35 mils for insulation, this leaves ·140in. for depth of copper and tape; (·140in. × ·600in.) will give the section required. This insulated tape will thus measure (·175in. × ·635in.), and the length of core taken up by the secondary will be 8 × ·635 = 5·1in.

Insulating flanges are required between the segments and also between the two compartments of each segment. The space taken up by these, with the necessary winding clearance, will be about 2in. The end flanges will be thicker, and clearance will be required between them and the yoke which will account for another inch. Thus we get for the length of core:

Primary wire	7·2
Secondary wire	5·1
Flanges and clearances	3·0
	15·3

Say, 15·5in. in between yokes. This only makes the transformer half an inch shorter than the rough sketch, Fig. 6.

From Fig. 7 we see that the space allowed between core and yokes is just that required, so that the length is the only dimension needing alteration. The copper circuit calculations will therefore be correct, and will not need alteration, as might have been the case if, for instance, the depth of winding had to be increased owing to the wire taking up too great a length on the core. We will therefore proceed to carefully calculate the iron losses and magnetising current. Assuming, as before, that the total section of the two yokes together is equal to that of the core, the volume of iron = 13·1 × 47in. = 616 cubic inches, or 172·5lb.

For $\tau_2 = 76$, the exact F from (1) is 302,000 C.G.S. lines,

therefore $$\mathfrak{B}=\frac{302{,}000}{84\cdot 5}=3{,}580.$$

From curve 4 this corresponds to a loss of ·84 watt per pound, so that the total iron loss is 172·5 × ·84 = 144·8 watts. From this we get that the current required by the iron losses at open circuit $=\frac{144\cdot 8}{2{,}000}=\cdot 0724$ ampere $= i_{\mathrm{H}}$ Fig. 3.

The next step is to calculate i_μ, the current required by the permeability of the iron. This is got by means of the formula (2):

$$i_\mu=\frac{\mathfrak{B}\,l}{\mu\,\tau_1\,1\cdot 76}.$$

For this transformer, l, the mean length of the magnetic path in centimetres, is 123 ;
$\mathfrak{B}$ = 3,580 ;
μ at this induction, from Fig. 5 = 1,960 ;
τ_1 = 1,490 ;

$$\therefore i_\mu=\frac{3{,}580\times 123}{1{,}960\times 1{,}490\times \cdot 176}=\cdot 0858 \text{ ampere.}$$

As from Fig. 3, i_{H} and i_μ are the two sides of a right-angle triangle, we obtain the magnetising or no-load current by taking the square root of the sum of the squares of these two. Thus:

$$i=\sqrt{i_{\mathrm{H}}^2+i_\mu{}^2};$$
$$=\sqrt{\cdot 0724^2+\cdot 0858^2};$$
$$=\cdot 112 \text{ ampere};$$

which is 3·74 per cent. of the full-load current in the primary.

Now, completing the details for the primary copper by aid of (4), we get the resistance from

$$r=\frac{\pi\,\tau_1\,11\cdot 75}{d^2}\,10^{-6};$$
$$=\frac{1\cdot 97\times 1{,}490\times 11\cdot 75}{\cdot 072\times \cdot 072}\,10^{-6};$$
$$=6\cdot 69, \text{ say } 6\cdot 7 \text{ ohms.}$$

It will be seen that when the full primary current of three amperes is flowing, this gives a loss of 20 volts as intended.

The weight is now obtained from

$$g=d^2\,\pi\,\tau_1\,3\cdot 02;$$

placing the respective values of d, π, and τ_1 we get g = 46lb.

The secondary is next treated in the same way by aid of (3), which applies for strip or any wire when the section is known.

Hence, $$r=\frac{\tau_2\,\pi\,9\cdot 2}{\mathrm{S}}\,10^{-6};$$

or, placing in the value as determined above,

$$r=\frac{76\times 1\cdot 96\times 9\cdot 2}{\cdot 083}\,10^{-6},$$
$$=\cdot 0166 \text{ ohm.}$$

This when multiplied by 60 amperes, the maximum current, gives us a drop of one volt. This forms a check on the accuracy of the previous work, in which the one volt drop was assumed.

The weight, g, equals S $\tau_2\,\pi$ × 3·85, and so

$$g=\cdot 083\times 76\times 1\cdot 96\times 3\cdot 85,$$
$$=47\cdot 5\text{lb.}$$

Now collecting the details of the design together, we get the following list:

Six-Kilowatt Transformer, Shell Type.—Ratio of transformation, 2,000/100 volts; $\frown\smile$ = 100.

Core, 4in. square; area of iron, 84·5 square centimetres $\mathfrak{B}$ = 3,580, F = 302,000, l = 123.

Primary: τ_1 = 1,490. π = 1·96.

Conductor, 72-mil wire wound in four segments of two divisions, as follows.

5 divisions of 19 layers of 10 turns.
3 „ „ 18 „ „ 10 turns.

Maximum depth of winding, 1·7in.

r = 6·7 ohms; loss = 1 per cent.; weight, 46lb.

Secondary: τ_2 = 76. π = 1·96.

Conductor, strip (·140in. × ·600in.), wound in four segments of two divisions, as follows:

4 divisions of 10 layers of 1 turn, and
4 „ „ 9 „ „ 1 turn.

Maximum depth of winding, 1·75in.

r = ·0166 ohm; loss = 1 per cent.; weight, 47·5lb.

Losses—Iron .... 144·8 watts, or 2·42 per cent.
Copper, primary... 60 „ 1 „
Copper, secondary 60 „ 1 „
264·8 watts.

$$\text{Therefore the efficiency at full load} = \frac{6,000}{6,264·8}.$$
$$= 95·6 \text{ per cent.}$$

The watts wasted in the iron at no load are 144·8, and the apparent watts at no load = 2,000 volts × ·112 ampere = 224 watts.

$$\text{So the power factor in this case} = \frac{144·8}{224} = ·648.$$

The weight of iron = 172·5lb., at 4d. per pound = 57·5s.
„ copper = 93·5lb., at 10d. per pound = 78·0s.
Total...... 266lb. 135·5s.

Dividing by the output, we find that the results have been obtained by using 44·3lb. of copper and iron per kilowatt, and at a cost of 22·6s. for the materials; also that the ratio of weight of copper to weight of iron = ·55.

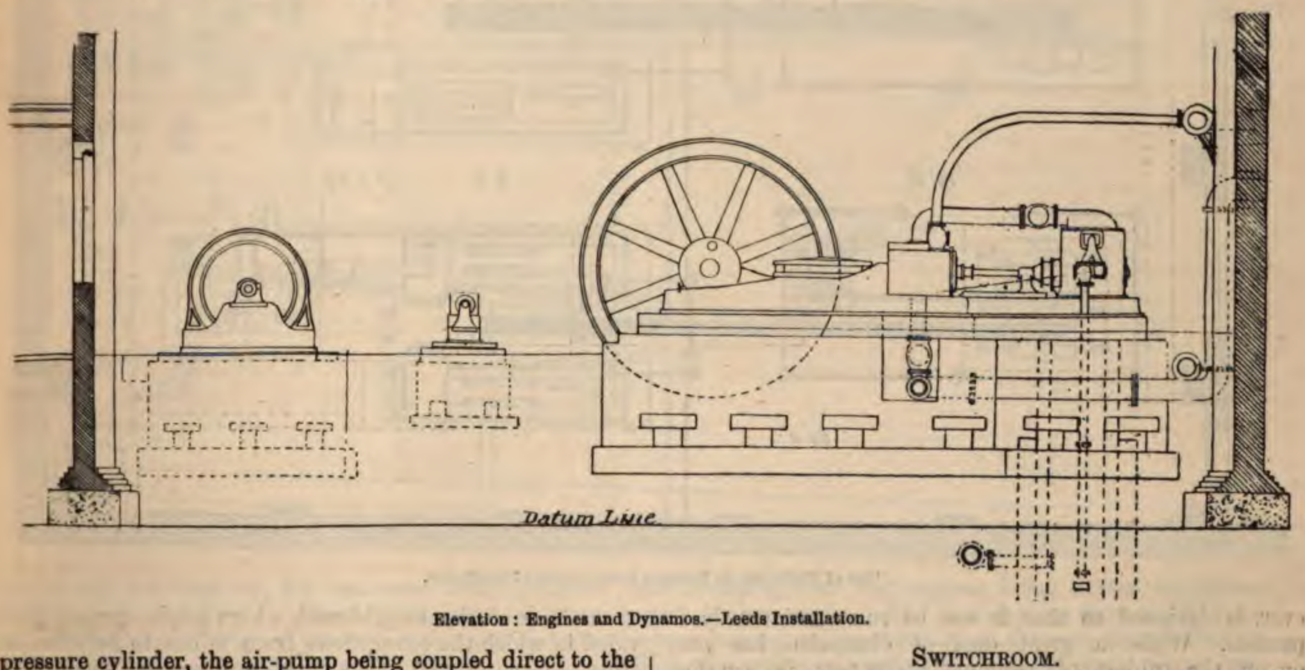
(To be continued.)

LEEDS.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

(Continued from page 513.)

Injection condensers are employed in conjunction with the engines, the air-pumps, condenser, and hot-well being formed in one casting and fixed to the bed-plate at the back of the low-pressure cylinder, the air-pump being coupled direct to the low-pressure piston-rod working through the back of the cylinder cover. A great deal of care has been exercised in providing for the lubricating arrangements, the supply of oil being regulated, caught after first use, conveyed to a suitable reservoir, filtered, and used again, thus greatly economising this too often fruitful source of waste. The smaller engine details are as follows: Speed, 120 revolutions; maximum at 140lb. steam pressure, 125 i.h.p.; high-pressure cylinder, 10in. diameter; low-pressure cylinder, 18in. diameter; stroke, 20in.; flywheel, 10ft. The flywheels of the engines are grooved for rope driving, this being found by far the most easy and economical method of working, 10 ropes of 1¼in. diameter being employed.



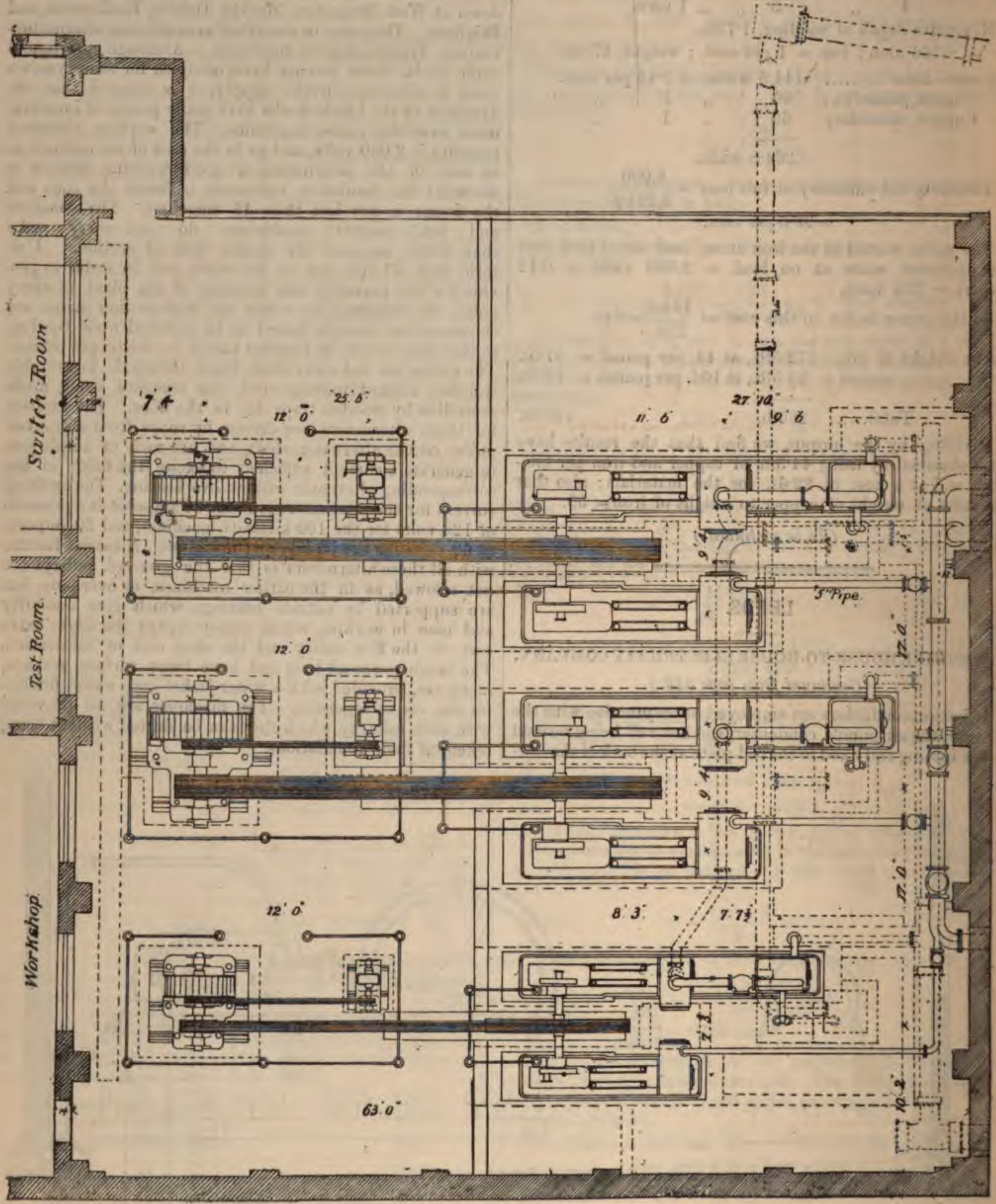
Elevation: Engines and Dynamos.—Leeds Installation.

DYNAMOS.

The alternators are of the Lowrie-Parker type, as laid down at West Brompton, Madrid, Dublin, Eastbourne, and Brighton. They may be described as multipolar alternating-current dynamo-electric machines. Although alternators made under these patents have occupied for some years a place in alternate-current supply, it is claimed that the dynamos in the Leeds works have many points of improvement over the earlier machines. The working electrical pressure is 2,000 volts, and as in the case of the engines, so in that of the alternators, a good working margin is allowed; the insulation resistance between the coils and the frame is not less than 15 megohms. The armature and field-magnet conductors do not carry more than 2,000 amperes per square inch of section. Uniform with all the rest of the work, and in order to provide for the perfectly safe working of the plant at every point, the terminals to which the high-tension mains are connected are securely boxed in by polished wood lagging, so that they cannot be touched except by the proper official. The cables are led away from these terminals in suitable trenches formed underground, the trenches being made accessible by wooden traps let in the floor. The exciters for these alternators are driven by ropes from a grooved pulley on the alternator shaft, and are each of ample size to generate a current sufficient to excite the fields of the corresponding alternator without overheating. The exciting current for the alternators is about 30 amperes at a pressure of 120 volts for the 100-kilowatt machines, and 30 amperes at 60 volts for the 50-kilowatt machines. A special feature with all these alternators is that the grooved pulleys are not allowed, as in the earlier machines, to overhang, but are supported by outside bearings, which give a solidity and ease in working which amply repays the slight extra cost on the first outlay and the after cost of lubrication. The bearings are all long and have large surface, and are, moreover, provided with a water-jacket and water fittings for use on emergencies. The machines are all provided with slide rails, by which they can be shifted without being taken off their foundations.

SWITCHROOM.

In the switchroom there is a magnificent display of the most modern appliances for the purpose of controlling the circuits and maintaining the voltage on the lamps free from variation. The engineers of the works claim that the switchboard is unequalled by that of any similar works in Europe. It is constructed under the Lowrie-Hall patents, and on the lines of that of the works at West Brompton, also erected by Hammond and Co., and provides in the simplest possible manner for the putting on and off of the various circuits and dynamos, any circuit and any dynamo being interchangeable. It also provides the special apparatus known as a synchronising board, which is necessary when the alternators are run in parallel or when the load is changed over from one alternator to the other. The plant, however, is designed so that it can be run continuously in parallel. While a great deal of discussion has gone on on the subject of running alternators in parallel, it is, we believe, the claim of the company's engineers that only in the works laid down by them in England is it the regular practice to run in parallel, by which means a great economy in work is effected. Like the rest of the plant, the switchroom exhibits the same advance and embodiment of later improvements as have developed in practice—for instance: the Lowrie-Hall fault detectors, which formerly were inserted from time to time by means of a test plug to prove whether there was leakage on the mains, are now a permanent part of the switchboard arrangement. On the switchboard will also be found the Gay paralleling device, by which means the plant is efficiently protected should any breakdown of a section of the plant occur. The trenches containing the cables lead into the switchroom at the back of the switchboard, where ample space is provided in which the connections from cables to switches or cross connections on the switchboard can be easily and safely inspected; at the same time it is kept perfectly private, except for the proper officials. At the back of the switchboard the connections are all suitably labelled, so that the attendant in charge has always before him a means of tracing the connections. The switchboard is designed to deal with three circuits, and is complete with all the neces-



Plan of Machinery in Dynamo Room.—Leeds Installation.

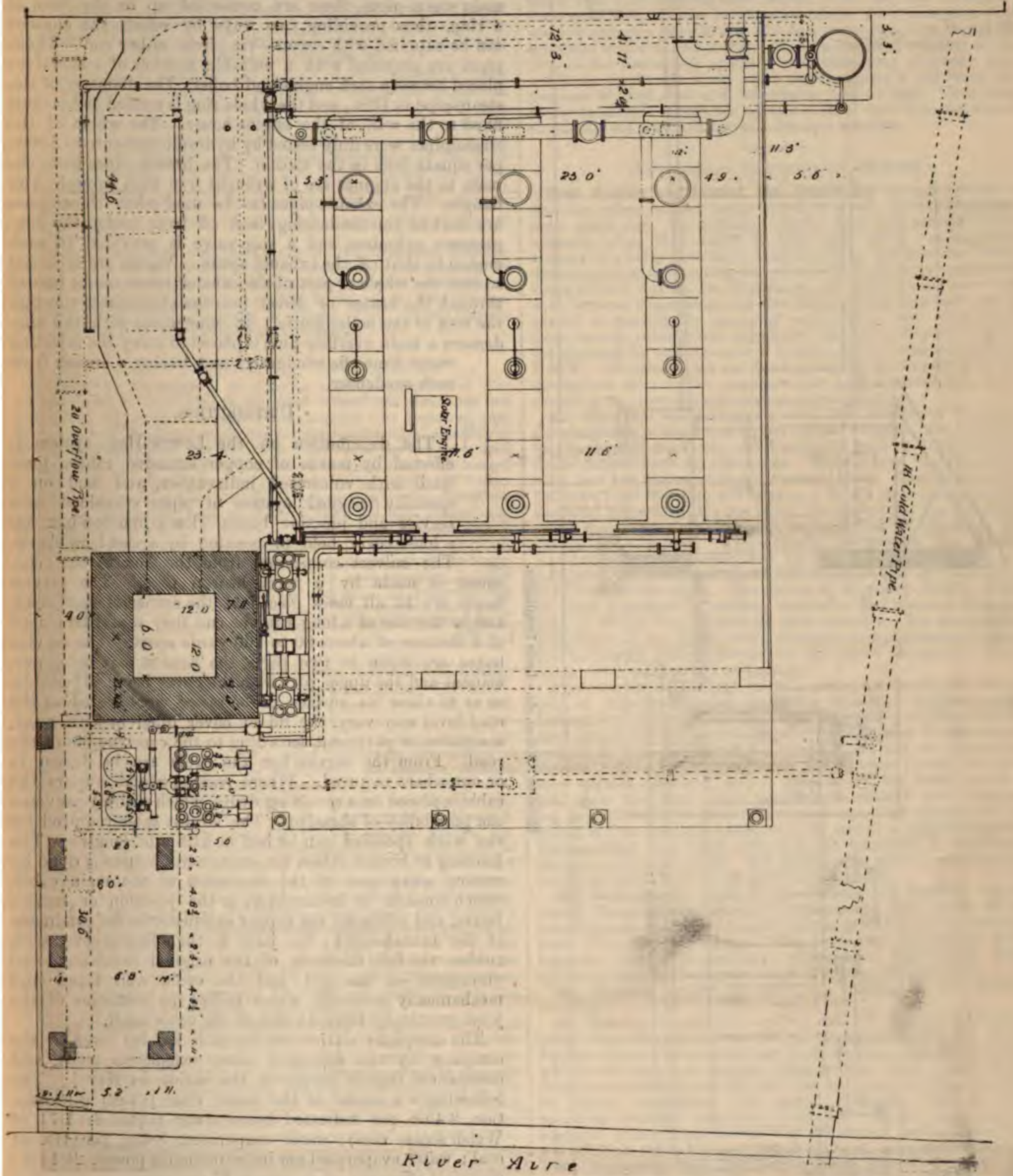
ary instruments for showing current or pressure for witching exciters on or off, and for regulating the voltage, o as to preserve a constant potential at the lamp terminals f the consumer, in accordance with the special regulations n this head made by the Board of Trade.

TEST-ROOM.

An electricity supply station is not complete without a roper test-room, and in this respect the station under review is well provided for, the test-room being supplied with Thomson standard voltmeter, Siemens dynamometer, Wheatstone bridge, Thomson reflecting galvanometer, etc.

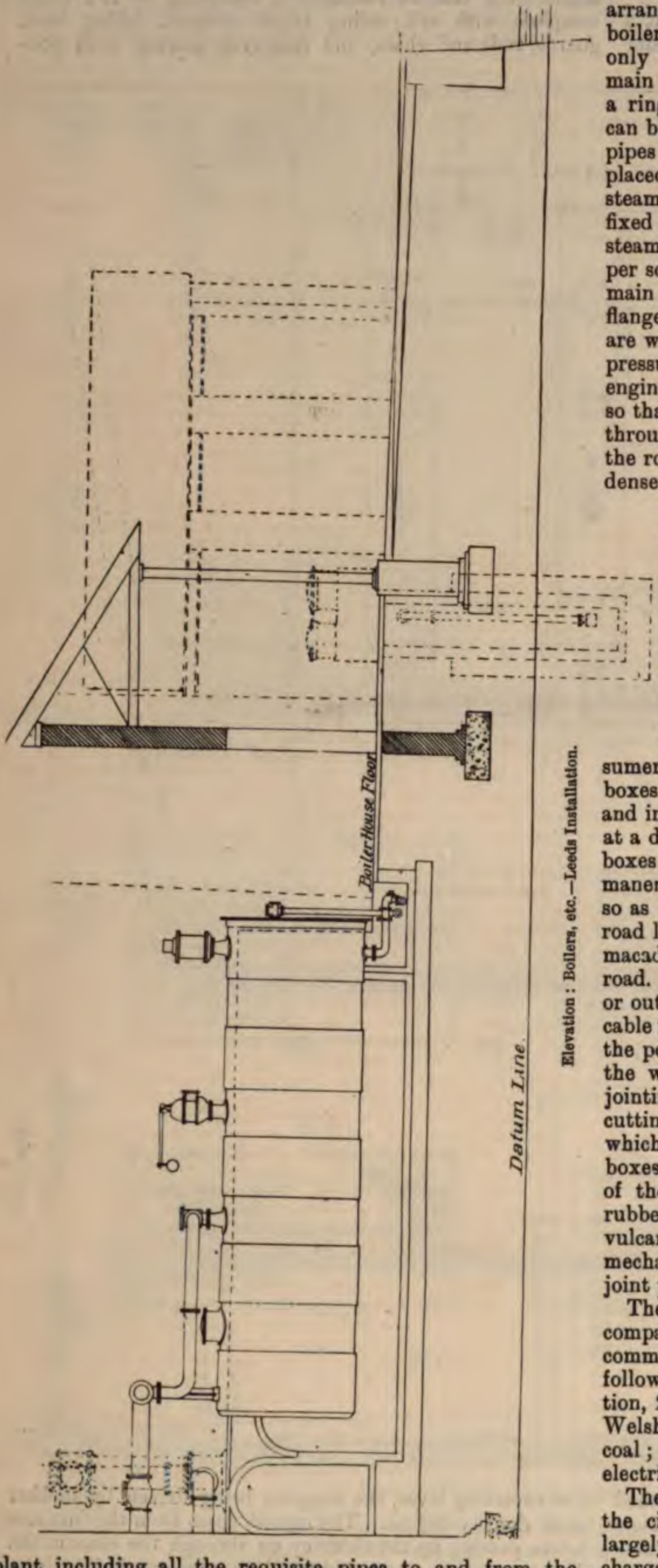
BOILER-HOUSE.

The boiler-house has also had special care bestowed upon it. It is 52ft. wide by about 48ft long. The boilers, three in number, 30ft. long by 8ft. in diameter, are very strongly constructed and fully capable of working at a daily working pressure of 140lb. per square inch. The fittings and mountings on these boilers are all of modern type. In order to provide for economical working these boilers are fitted with mechanical stokers. These stokers are worked by means of a small engine driving a belt on to a line of shafting, and thence on to the actual stokers' shaft by ropes in the usual way. A further economy is effected by means of a Green's economiser, consisting of 192 tubes complete with self-acting triple scrapers, lifting bars, guards, rods and chain, and improved gearing with positive reversing lever, the scrapers being driven by another small donkey-engine. The heated gases from the furnaces before passing up the chimney go through the economiser. This economiser was tested to 350lb. pressure before leaving maker's works. In case the engines are worked non-condensing a feed-water heater is provided, by means of which the exhaust steam is used to heat the feed-water. The combination just indicated constitutes the most modern arrangement for an economical station. After leaving the heater the exhaust steam passes up to the



atmosphere through a special pipe instead of into the chimney-shaft, as this is found to have special advantages over the older method.

SYSTEM OF STEAM CONDENSER, ETC., PIPES.



Elevation : Boilers, etc.—Leeds Installation.

As might be imagined, a very careful arrangement of pipes was rendered necessary by so many auxiliary parts of the plant, including all the requisite pipes to and from the condensers, pumps, tanks, and filters. It may be here mentioned that although a good supply of water was obtained by a river site, the character of the water was found very bad, there being a great deal of suspended matter in the water. In order to meet this difficulty two water-filters are supplied, each capable of filtering not less than 2,000 gallons per hour. The pumps in conjunction with these filters are of the horizontal type, each capable of pumping not less than 2,000 gallons per hour. The donkey-pumps for feeding the boilers are of the duplex ram type, each of sufficient capacity to feed two boilers when working at their full power. The pumps draw their water from their filters, and the feed pipes are arranged for delivering the water either direct into the boilers or to the water-heater, and through the economiser only into the boilers. Referring now specifically to the main steam-pipes, these are connected up in the form of a ring, thus providing two ways by which the engines can be supplied with steam—viz., from either end. These pipes are provided with a suitable number of stop-valves placed between each engine and boiler. The diameter of the steam-pipe is 10in., and the whole ring is carried on brackets fixed to the wall of the engine-house. The whole of the steam-pipes were duly tested by hydraulic pressure to 300lb. per square inch in the station. The branch pipes from the main to the engines are of wrought iron with wrought-iron flanges. The exhaust-pipes (to be used when the engines are worked non-condensing) lead off from under the low-pressure cylinders, and a stop-valve is provided to each engine to shut off the exhaust steam. Valves are arranged so that the whole or part of the exhaust steam can be turned through the heater or direct into the atmosphere through the roof of the boiler-house. In connection with the condensers a main overflow-pipe is placed to carry the injection water from the condensers and having a branch from each condenser.

DISTRIBUTION.

The distribution on the Lowrie-Hall system is effected by means of copper stranded cables, insulated with vulcanised indiarubber, and laid on a specially-designed system of pipes combined with service and junction boxes. Each junction-box has a loose cover, held in position by a cast-iron clamp. The culvert connection from the box to the consumer is made by a wrought-iron pipe. The service boxes are in all cases placed at the corner of each road, and in the case of a long straight run they would be placed at a distance of about 80 to 100 yards apart. The service boxes are made in two parts, the bottom part being permanent and the upper part with the cover being adjustable, so as to allow its surface to be raised or lowered as the road level may vary, the lid or cover filled in with wood, macadam, or pavement according to the construction of the road. From the service box the cable can be drawn in or out where required. Where passing round corners the cable is placed on a revolving drum, which entirely prevents the possibility of abrasion. The largest cable required for the work specified can be laid in half-mile lengths. The jointing of branch cables for consumers' houses is done by cutting away part of the insulation of the main cable, which consists of indiarubber, in the junction or service boxes, and soldering the copper conductor to the conductor of the branch cable; the joint is then lapped over with rubber the full thickness of the original insulation, and vulcanised on the spot, and the cable well taped and mechanically protected, which makes the insulation of the joint practically equal to that of the cable itself.

The completed station was formally handed over to the company by the engineers after exhaustive trials, and commenced regular supply on the mains on May 1. The following is a *résumé* of the tests: Coal (slack) consumption, 2·45lb. per indicated horse-power (equal to 1·71 of Welsh steam coal); water evaporated, 8·6lb. per 1lb. of coal; water evaporated per indicated horse-power, 21·11lb.; electrical efficiency of dynamos, 93 per cent.

The company begins business with 7,000 lights fixed on the circuit, and there is every prospect of these being largely added to. Under the provisional order the rate of charge authorised is 8d. per Board of Trade unit, but by a system of discounts the price ranges practically between 5½d. and 6¾d. per unit.

The whole of the plant has been erected under the supervision of Mr. Robert Hammond, M.I.E.E., the consulting electrical engineer of the company, and the total cost, excluding land, has been about £27,000.

INSTITUTION OF ELECTRICAL ENGINEERS, May 25.

Mr. W. H. PREECE, F.R.S., President, in the chair.

The following candidates were balloted for:

Foreign Member.—Toraji Bannai, M.E., The Tokyo Electric Light Company, Tokyo, Japan.

Members.—Captain Chesney, R.E. (Local Major), Assistant Director of the Indo-European Telegraph Department, Teheran; Prof. James Alfred Ewing, F.R.S., Engineering Department, Cambridge University.

Associates.—Richard Clay, 56, Wisteria-road, Lewisham, S.E.; Arthur Ernest Chandler, Indo-European Telegraph Co., Teheran; J. Torr Todman, 427, Mansion House-chambers, London, E.C.

Students—Hugh Samuel Davidson, 58, Alderney-street, Eccleston-square, S.W.; Alfred Freeman, 50, Hilldrop-crescent, Tufnell Park, N.; Frank Gibson Travers, 49, Albert Hall-mansions, S.W.; Roderick Sidney Travers, 49, Albert Hall-mansions, S.W.; Arthur E. Mayes, Fern Bank, Hendon-lane, Finchley, N.

After the formal reading and signing of the minutes, a letter was read from the American Institution of Electrical Engineers to the effect that the authorities at Chicago had granted that Institution two rooms at the World's Fair, where any members of the London Institution would be heartily welcomed. The house of the American Society of Mechanical Engineers at 12, West Thirty-First-street, New York, is also placed at the service of English members.

It was unanimously resolved that the Secretary be authorised to acknowledge this cordial invitation, and to return the thanks of the Institution.

The **President** then read the report on the Salomons Scholarship to the effect that owing to fortunate circumstance of receiving two dividends on the £1,000 first presented, and one on the subsequent £500 presented by Sir D. Salomons, two scholarships of £35 had been awarded: to Messrs. F. R. Lydall (King's College) and J. T. Morris (University College).

DISCUSSION ON MR. SAYERS' PAPER, MAY 11.

Prof. S. P. Thompson, in opening the discussion, said Mr. Sayers had not only tried to do what others had done but had succeeded, and it was the man who succeeded who deserved congratulations. The great want was for more mechanical armatures. When Mr. Swinburne and Mr. Brown produced the tunnel-wound machines it was thought we should have no more armatures wound over with wire. But it was found these machines had the unfortunate property of sparking badly. The dynamos for the aluminium works at Neuhausen had to be sent back for this reason, and turned down to the old method. Mr. Sayers had shown a good mechanical way of overcoming the difficulty. To secure sparkless commutation of a section he departs from Gramme's arrangement of coils in series, brings the winding back, putting another E.M.F. in it, which dams back the current. (A diagram was shown, each coil in the armature being represented as a cell; then, if the wire is brought back and an extra "cell" put in between coils and each commutator segment, these extra E.M.F.'s oppose the short-circuit current and prevent sparking.)

In answer to Prof. Ayrton, **Mr. Sayers** said the commutator coils were always on open circuit, except when under the brush.

Mr. Swinburne said in a few years we should look back to this paper as the greatest advance in design of direct-current dynamos during the last 10 years. This sounded a large thing to say, but the closer one looked into the method employed, the clearer it would be seen there was more to follow. As regards formula for maximum output, he had worked out the formula in 1887 and published it. In those days the output was limited by various quantities. Mr. Sayers shows a new state of things in which we hardly know what the output will be limited by. He thought Mr. Sayers ought to have mentioned the smallness of the connections, which had to carry current only for a very short time. He had discussed hole-wound armatures with Mr. Crompton, but came to the conclusion they were not practical. The importance of hole winding on maintenance was great—the armature could be rolled about the floor, Foucault currents were got rid of, there were no mechanical forces acting on the wire—all force was on the iron and not on the copper; it was of great importance to get the torque transmitted through iron and not through cotton, shellac, and other such messes. He would ask people to note the last paragraph of Mr. Sayers's paper carefully.

Mr. Housman gave some diagrams, to show that at the change of direction of current by commutator the current is dammed back in a more or less irregular curve; if rapid variation, the curve is very steep. This explained the difference in speed of dynamo and motor. He pointed out also the extreme importance of the surface resistance between brush and commutator. If the brushes are not placed right all the current is crowded to one part of the brush, and consequently there is fall of potential. Ordinarily the surface resistance is $\frac{1}{1000}$ ohm per square inch; but it is often three or four times this: at full load there may be ·4 volt between brush and commutator. By shifting the brush there may be half a volt difference between tip and heel of brush, and this represents an E.M.F. that has a similar effect to Mr. Sayers's arrangement. If the brush is overloaded, the under surface gets fused and roughens the commutator.

Mr. Mordey agreed with Mr. Swinburne that this was the most important paper on direct-current dynamos since that of Hopkinson in 1886. He was quite sure that the last words of the paper were true, that we were on the eve of great improvements in dynamo construction. No doubt the invention would be followed up by theorists with columns of mathematics; he wondered why they had not reasoned out themselves such a result. He did not see the necessity of having the excitation only on the armature—it would be best where most space was to spare. There was a limit to the current density in armatures; it would be more economical on the field magnet. There would be no limit to output but heating. The machine would be self-regulating, sparkless, and with no drag on the wires. There would be a difficulty with high-tension machines, as here there would be a mass of fine wires, difficult to thread in holes. The difficulty had been met with in America. He congratulated Mr. Sayers on his paper.

Mr. S. F. Walker was afraid he must throw cold water on the enthusiasm from a practical point of view. There were many difficulties in the way—it was very difficult to insulate wires properly in a channel; there would be a great amount of heating confined in a narrow space. He had gone into the matter and found that if the sections were turned down and the interspaces filled with wire, a better machine was made. As to clearance, $\frac{1}{16}$in. was not enough; good fitting will do a great deal, but in use the armature would be sure to rub. He was doubtful whether all the devices for decreasing sparking and increasing efficiency were worth the candle—for 1 or 2 per cent. increase of efficiency, the increase of first cost and attendance had to pay. They were rarely successful except for special cases; their true use was in advancing the standard of really efficient machine.

CONTINUATION OF DISCUSSION, MAY 25.

Prof. Ayrton commended Mr. Sayers for having carried so well into effect notions propounded by Profs. Ayrton and Perry some years ago. In orthodox circles field and armature were opposed, when they ought to help each other. A laughable analogy of a horse drawing a loaded cart in one direction with a donkey pulling in the other was advanced. Orthodoxy against the views of Prof. Ayrton, Dr. Hopkinson, and others would have none of it, because of sparking, but Mr. Sayers takes the best way to get rid of sparking by means of commutator coils. Some time since, among other plans suggested, was one by himself to damp the sparking by an extra pair of brushes and an external source of E.M.F. He pointed out the disadvantage of Mr. Sayers' plan was having two coils in the armature, but congratulated him upon adopting the principle and getting rid of sparking.

Mr. Snell said that he together with Mr. Swinburne had tried the suggestion of Prof. Ayrton but did not succeed. He was sorry Mr. Sayers had tried only the Paccinotti type of armature, and feared difficulties with other types. He had tried toothed armatures, but had had to go back to smooth cores. The limits of output were two—sparking and heating. In his experience, heating was most important. He was afraid Mr. Sayers put the compound coil in the wrong place—it could be controlled in the fields but not in the armature. Theoretically, he thought Mr. Sayers' machine would be larger, but he had roughly measured and calculated the armature shown (40 units) should give 35 units, so this might not apply. The device, if it gained weight, would be more important in motors, especially for traction, where a gain of 20 per cent. would be most valuable. He thought the publication of the device would deprecate manufacturers' stocks; but he himself looked forward to the entire abrogation of the commutator on dynamos and motors.

Prof. Forbes said he had recently seen a similar device used by one of America's most ingenious electrical engineers—Mr. Eickemeyer—in experimenting with alternating-current motors. Most people did not appreciate why series-wound direct-current motors, if with laminated fields, could not run on alternating circuits. If a current is sent in by one brush it goes in a certain direction, and if sent in by the other brush it still goes the same way, therefore it seemed that alternating currents could be used. But great sparking occurs and the reason is that when the armature is at rest it is magnetised and demagnetised at a rapid rate, and the induction in the short-circuited coil is enormous. Mr. Eickemeyer used a separate coil to oppose the E.M.F. of the short-circuited coil.

Mr. Siemens said, being a manufacturer, he disliked innovations. The device introduced complications. The object of the manufacturer was to give a good machine at least cost for given output. The extra coil seemed fancy work, and introduced extra expense, when with ordinary construction they could make sparkless dynamos without change of brushes for any load.

Mr. Chamen testified to the good working of Mr. Sayers' machine.

Mr. Mordey thought the meeting did not appreciate the chief point—that the device enabled us to approximate the direct current dynamo to a transformer by doing away with the air-space which cost money in energy. The ampere turns were reduced from thousands to hundreds, and the armature current was used to obtain excitation. He agreed with Mr. Siemens that sparkless dynamos were now produced, but at what cost of copper! The real point was that the device enabled makers to get rid of air space and save copper without losing sparklessness.

Mr. Crompton said the problem was one of expense. He agreed dynamos were perfect, but they cost too much to make. He asked what was the comparative weight of material and amount of labour. Others had tried to reduce air space by sunk winding—Swinburne, Brown, Wenstrom, Ganz—and all had returned to smooth winding. If Mr. Sayers has achieved success, he has indeed done a great work; but quantitive results were required.

Mr. Swinburne said it seemed to be overlooked that the device was applicable to other than sunk winding.

Mr. Trotter asked Mr. Sayers if he would publish a detailed estimate of his dynamo as compared with the ordinary dynamo.

Mr. Sayers then replied, and it was suggested that in the printed report of the discussion he should amplify his remarks.

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ALTERNATE-CURRENT MOTORS.

Old notions as to the possibilities of electrical development are being rudely put aside. Even now men are too prone to say "can't" when their interests or their prejudices make the wish father to the thought. 'Tis only a few short years since the possibility of alternate-current motors was generally doubted, then Mordey and others proved them to be possible on a large scale, but small motors were for the moment not forthcoming. Still, the possibility once admitted, time was the only factor required for their production—brains and mechanical skill were sure to be forthcoming. And now we are to have them, small and large, in shoals, so that within a year or two alternate-current motors will be as common as direct-current motors, and thus one of the stock objections to alternate-current distributing systems will become valueless. Assuming, then, that direct or alternate current motors will be equally available and equally economical, the authorities in charge of our central stations must bestir themselves to equalise the load day and night. An important question, however, will present itself to the designers of central stations, whether the distribution of power will necessitate the use of separate mains. The cost of mains is now one of the biggest items, and if further provision is to be made the cost will be greatly increased. Our knowledge at the present moment points to the necessity of such mains; but who can say the devices possible to obviate such necessity? When gas-engines were first put on the gas-mains they caused a considerable fluctuation and flickering of the gas lights; but means were soon devised to stop the trouble, and thousands of gas-engines are now served without complaint. The difficulties may be greater when electricity is in question, but when, on the one hand, we have thousands of pounds increased cost of mains, we may be sure attempts will be made to save this, while, on the other hand, the light is to be kept steady. It will be far better for designers to look ahead and provide for the general introduction of small motors than to have to overhaul their work almost before it is put down. Our readers are well aware that for years our contention has been that the general introduction of electric motors for the moving of small machines will be an immense saving to the industrial population. Small steam-engines are very wasteful, and though it is difficult to estimate the saving, and almost impossible at present to get users of motors to give exact figures, we have seen and heard enough to know that we can hardly over-estimate the saving. No small workshop owner seems to know what his old ramshackle engine really costs him. He gets a rough idea from his coal, water, and wages bill, and is continually grumbling, but exactitude is unknown. What power he gets for his long bill is also unknown, but ofttimes we have seen a ten horse-power nominal constantly at work to give about five or six horse to actuate the machinery. If it had to give thirty or forty there might be economy in its use, but under the ordinary conditions the annual cost per horse-power would frighten most of us. The alternate-current motors now being offered to the market seem to fairly fulfil the conditions required, so that the increase in the use of electrical energy as a motive power ought during the next few years to be extraordinarily rapid.

SUCCESS OR FAILURE.

It is difficult to know the right way to spell "success," but the history of the electrical industry proves that something is radically wrong with methods of trading. New firms come and go like men, while older firms continue to live and thrive. Is it that the older firms transact their business in a proper manner, whilst the new ones act contrary to the plainest rules of economical trading? Ninety-three has seen quite a number of houses close their doors, and electrical business will know them no more. So far as we can ascertain, the moral of the story is twofold, and the unfortunate part of the business is that the moral teaching has little or no effect. We are afraid that the larger and older firms are not altogether free from "cutting prices," and this failing seems to have been the ruin of most of the newer and weaker concerns. What is the use of attempting to do business under cost price? The men who do this systematically are both fools and rogues. They not only ruin themselves, or the people who lend them money, but they disturb business relations all round. A buyer cannot tell that a business is preparing for its degree in the bankruptcy court, and naturally turns from the higher prices quoted by firms whose business is neither philanthropic nor roguish, but who desire to make a good article, sell at a good price, and obtain a fair profit. We have never yet found that buyers object to pay a fair profit, but owing to these underselling propensities they are led to believe that legitimate traders are overselling, and so trying to make too large a profit. The public will not and cannot be expected to believe that men come to business and offer goods at prices which will not pay. There is not a shadow of a doubt, however, but that large volumes of business have been transacted without the chance of getting a penny profit. If the men answerable for this state of things erred through ignorance, their position should rather have been Hanwell than in business premises. Ignorance is no excuse. A man is never so ignorant, if he be not an utter idiot, but he knows his ignorance and might take counsel on the subject. We may be thought to be thrashing a dead horse, but it is not so. There is hardly a day passes but we hear of quotations for work and for apparatus at preposterous prices. It is not for a buyer to tell a man that he does not charge enough; the buyer's place is to buy the best thing in the cheapest market, and to see he gets what he bargains for. The sympathies of the best firms are with us in this crusade. Theirs is a difficult part to play. They have reputations to keep up, are desirous of giving good materials and doing good work, yet often have to take a back seat because someone with no reputation to lose offers materials which superficially can hardly be detected from the real thing, yet are intrinsically much less valuable, and whose workmanship is not of the best. The prices of the latter are less than those of the former. Naturally so, and the work must be done before the buyer realises his mistake.

REVIEWS.

Electricity up to Date. By John B. Verity. F. Warne and Co., London and New York. 1s. 6d. Third Edition.

A third edition of Mr. Verity's little book has been issued, proving the popularity of the work. This time it comes with a red cover and a frontispiece in the shape of an illustration of the Liverpool overhead railway. A chapter has been added on "Electro-Therapeutics," very properly discrediting electropathic belts, "electric" hair-brushes, and suchlike traps for the ignorant; and as the book seems widely read, this is distinctly a gain to the public knowledge. The real utilities of electricity in medical work are touched upon in this chapter, and the investigations on "cataphoric medication" and other applications of electricity to medical science are mentioned. As for the main body of the book, it is apparently unaltered in spite of being "thoroughly revised" from the first edition, which we fully dealt with on December 18, 1891. We have the same useful information, but with the same little errors uncorrected. Electricity is still obtained by the "destruction" of zinc; an alternating current (p. 18) still gives "a continuous flow." The popular idea that "electricity is stored" is still true, according to Mr. Verity (p. 38). Parallel wiring is still that in which "each lamp has its individual flow and return wire"; and Prof. Silvanus P. Thompson's name is still spelt in two different ways (p. 150). These matters ought certainly to be seen to in fresh editions. The remarks on wiring houses, on training electrical engineers, and so forth, are, however, as before, very pertinent; and that the book still sells well is best evidence of its usefulness.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CONNECTING COMPOUND DYNAMOS.

Sir,—Respecting running compound direct-current machines in parallel off one countershaft, the following remarks thereon may be useful to "Young Electrician." The writer should think that no modification would be necessary to put a compound dynamo into parallel when driven in this way, granting that all the machines are compounded for the same pressure at the same speed; but in shutting down, since the speed must not be altered, the best way to reduce the load would be by having a rheostat of suitable range placed in the shunt coils. The small rheostats usually provided with compound dynamos would not do, because these simply compensate for temperature, distance, or drop of pressure with various loads. Then when the load is sufficiently reduced, the machine could be thrown out of circuit, and the friction clutch attached to its driving pulley slipped. Care should be taken that the load is fairly small when switching out, otherwise the belt may get thrown off.

In reply to "Young Electrician's" second question: In the diagram on page 410, in issue of April 21, 1893, the negative mains from the three machines are joined straight on to the negative omnibus bar, and the positive are connected to the positive omnibus bar by switches. This is "single-pole" arrangement. In best modern practice "double-pole" is customary, so that the negatives should be supplied with switches also. The equaliser is joined on the *positive* brush. This is wrong: it should be joined on to the *negative* brush. Assuming that this change is made, then, as "Young Electrician" suggests, by putting three switches between the three negative mains and the negative omnibus bar, the three switches on the equaliser can be done away with, and the equaliser joined direct on to the three negative brushes. With this arrangement the machines will work right.—Yours, etc.,

Arthur F. Guy.

THE ELECTRICAL AND GENERAL ENGINEERING COLLEGE.

SIR,—I must ask you to kindly allow me to correct an error in the notice of the college in your issue of the 19th inst. The ordinary course at Penywern House for a student intending to enter the Central Institution occupies one and not three years. In some cases this time may be extended with advantage, but it is far more frequently curtailed, as with very few exceptions students who have come to Penywern House in January to be trained for entering the Central Institution have passed in the following September, and the great majority of those entering Penywern House in April have done the same. The second year's, or engineering, course is intended, not for students who will ultimately enter the Central Institution, but for those who wish to go through a comparatively short college course before going into engineering works. The third year's, or workshop, course, is intended to supplement the technical instruction given at our own school or elsewhere by a course of work under practical conditions in an engineering workshop, and during this course wages of 10s. a week are paid, subject only to deductions for time not put in or unsatisfactory work. These wages must be deducted from the fee of 260 guineas for the three years' course.

As residence is not compulsory, it hardly seems fair to include this in the estimate of the cost of a student's training. A large majority of the students live at home or with friends, and there is no difficulty in finding boarding accommodation in the neighbourhood of the college at from £1 a week upwards.—Yours, etc.,

G. W. DE TUNZELMANN.

Penywern House, 284, Penywern-road, S.W., May 22.

TRACTION v. TELEPHONY.

SIR,—It seems to me that this question is a three-sided one. It may be that the telephone companies are attempting to obtain the monopoly of an earth return, and this is no doubt a mistake; but why should the Electrical Traction Association obtain the monopoly? When cheap telephony was the cry, electric traction was practically unknown. Why, therefore, should traction obtain a monopoly which may seriously affect some future development of electricity?

Only last week you referred to Mr. Tesla's idea of transmitting Niagara's energy without wires. This scheme may be in the clouds, but can any man say that some future development of electricity will not be seriously interfered with by permitting electric traction companies to use earth returns to any extent they may desire?—Yours, etc.,

May 19, 1893. T. W. E. HIGGENS.

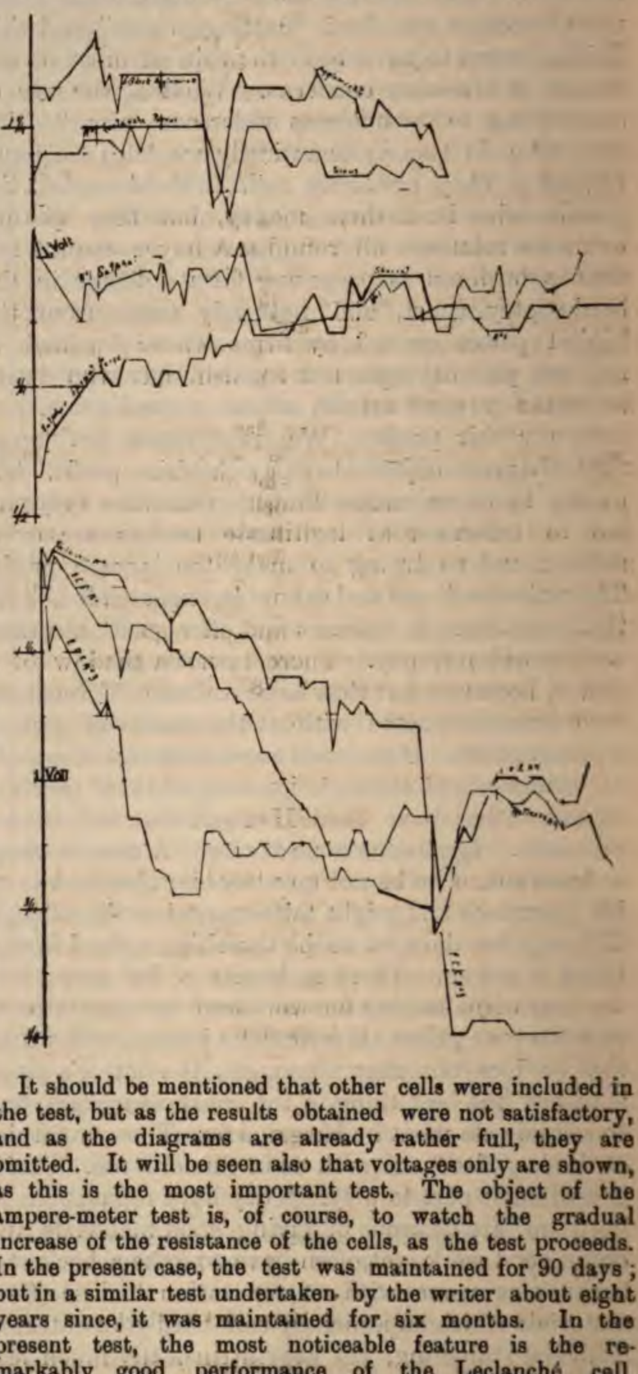
WET AND DRY CELLS.

SIR,—Some months since the writer made a series of tests of different forms of wet and dry cells, with the object of ascertaining, for his own information, if any of the latter could be used for telephone and electric bell work.

The cells tested were as follows: A six-block agglomerate cell, made by the Silvertown Company. A No. 1 Leclanché cell, with porous cell, made by the same company. A specially large cell of the sulphur-salammoniac type, invented by the writer some time since, the porous cell being 9in. high by 4in. diameter. A cell of the same type of the ordinary No. 1 Leclanché size. A No. 1 Hellesen dry cell. A No. 1 E. C. C. dry cell. A No. 2 E. C. C. dry cell.

The method employed in the test was one designed by the writer some years since. In his experience the only sure test is continuous work in the actual duty the cell is to perform; but as this often takes several years to accomplish, the test which most nearly represents this duty will be the most reliable. This, so far as the writer's experience goes, is not a breakdown test. That is to say, connecting up a cell on short circuit, or on a low resistance, or even on continuous work, such as ringing a trembler bell for hours or days together, do not furnish a safe guide as to what the cell will do when set to its own proper duty. The writer has tested cells himself, and has seen the results *of tests of cells by* others by all these methods which promised remarkably well but which failed most ignominiously when left to even comparatively easy work in the regular way.

His own plan is to connect together all the cells which it is desired to test in one circuit with a galvanometer and all adjustable resistance, the total resistance in circuit being arranged so that a very weak current is continually passing through each of the cells. The high-resistance circuit of an ordinary linesman's detector galvanometer is used, and any convenient resistance, provided that it can be adjusted as required, so as to maintain the current strength uniform throughout the test. If the resistance be arranged so that the galvanometer gives a deflection of 45deg., or thereabouts, it is an easy matter to maintain the current at the same strength from day to day. The strength of current employed would be a few milliamperes. Every morning, at about the same time, each cell is tested with a voltmeter and ammeter, or with the high and low resistance circuits of the linesman's detector, which answer very nearly as well, though, of course, not furnishing quantitative results. As any of the cells work out, they are removed from the circuit and allowed to rest, being replaced if they set up again. A full record of the tests is kept, any breakdowns and replacements being noted. The results of the test referred to above are shown in the diagrams.



It should be mentioned that other cells were included in the test, but as the results obtained were not satisfactory, and as the diagrams are already rather full, they are omitted. It will be seen also that voltages only are shown, as this is the most important test. The object of the ampere-meter test is, of course, to watch the gradual increase of the resistance of the cells, as the test proceeds. In the present case, the test was maintained for 90 days; but in a similar test undertaken by the writer about eight years since, it was maintained for six months. In the present test, the most noticeable feature is the remarkably good performance of the Leclanché cell, made by the Silvertown Company; but another remarkable feature is the great steadiness of the sulphur-salammoniac cells. The Silvertown cells were not included in the test until after the others had been at work 26 days, so that the time is shorter, as shown, but as the current was maintained at a uniform strength throughout, the comparison for the time the Silvertown cells were on is perfectly accurate.

A comparison of the curves for the two sulphur-salammoniac cells, the specially large one and the ordinary No. 1 size, shows also the effect of the larger carbon surface and the larger quantity of the depolariser present. Two agglomerate cells were tested, one with the zinc in a small porous cell, as supplied by the Silvertown Company, and one without the porous cell. As there appeared to be no appreciable difference between them, only one is shown on the diagram.

Of the dry cells it will be seen that though neither approach the wet cells in staying power, the Hellesen is apparently the best, while both the E. C. C. cells show what may be called a fairly good record for dry cells. That is to say, either the Hellesen or the E. C. C., it would appear, might be used where the work is very light, but neither should be employed where staying power is necessary.

It will be noticed, also, that the record of the behaviour of the cells is by no means regular. They follow neither a straight-line law nor a curve; their E.M.F.'s go up and down, but with the usual downward tendency as the test proceeds. The reason of this, the writer believes to be the changes of temperature in the testing-room, but he hopes to conduct an exhaustive series of tests to determine this later on. One effect of the temperature appeared to be the bursting of some of the E. C. C. cells when there was any considerable increase.

With regard to the value of the test described above, the writer has found it a wonderfully sure guide. A cell which shows staying power under this test can always be relied upon to perform good work when required to do so in practice; and, on the other hand, a cell which fails quickly under this test will invariably be found to be useless for any but the very lightest work, and even then to be exceedingly troublesome.

In the test which the writer has referred to, which he made about eight years since, he had some 20 cells under trial, including every one of the open-circuit cells then known, except the trough Daniell. The cell which stood best, and which was still at work after six months, was one made by the writer's firm at that time. The porous cell measured 7in. in height by 3in. in diameter, the carbon plate 8in. by 2in. by $\frac{5}{8}$in., and it was fitted with a brass clamp, and was a cut carbon from gas refuse. As a proof of the trustworthiness of the test, it may be mentioned that cells of that pattern, made in 1883, are still working, and doing their work well.—Yours, etc.,

SYDNEY F. WALKER.

QUACKERY.

An attempt is being made to form a company for the sale of the patented articles which "apply electricity or magnetism by means of medical plasters." In our view there are two ways in which the technical papers may frustrate such attempts—first, by continually harping upon the disgraceful way in which all manner of papers insert advertisements which the proprietors know are intended to mislead the public who read them; secondly, to warn the public against investing any money in these companies. Depend upon it, though the immense sums spent in advertising do for the moment bring in a return, the persistent efforts of the technical journals are not without effect, and education is rapidly advancing, making it more and more difficult to effect sales, so that investment even as a gambling transaction is not warranted. We know that many investors care little how returns come so long as they do come, and are large; but, as we say, every day makes it less easy to get these returns from an ignorant public.

Here is a copy of a prospectus which is being privately circulated. We say such plasters are rubbish, dubbed with a name which it is hoped may assist to effect a sale.

Private. [COPY.]

101, Piccadilly, Manchester, May, 1893.

We, the undersigned, are forming a Limited Company to purchase the invention, patent rights, etc. (Patent No. 7,617, April 14th, 1893), and to Manufacture and sell the articles referred to therein.

We have every confidence that with sufficient Capital a most valuable property will be created.

The Patent secures to us the sole right to *apply Electricity* or *Magnetism* by means of Medical Plasters for *Curative purposes*.

For many years Electricity and Magnetism have been applied by means of Belts, Pads, Lockets, etc., and thousands of Testimonials published from persons benefitted thereby. It is obvious that there will be a much greater advantage from the application of these forces in *Medical Plasters*. Their action will be more intense and continuous, from their attachment to the body, relieving pain, bracing and strengthening the nerves, as well as giving comfort and support at the same time. They are inexpensive, and brought within the compass of the poorest person. They will be sold like other porous plasters at 1s. 1½d. and 2s. 9d. each, and there will be found to be more efficacy in one of these Plasters than in most of the Belts and Appliances for which 2 guineas and upwards is regularly charged.

There are about 25,000 Chemists and Medicine Vendors in the United Kingdom, and to place any Patent Medicine on the Market in such a way as to insure success, involves a large expenditure in Manufacturing, Advertising, etc.

There will not be the same difficulty in inducing Chemists, etc., to stock and push the sale of these Plasters as there is in inducing them to push a new Medicine. They can sell their own medicines and recommend and push the sale of these Plasters as an additional source of profit.

Many Shops would doubtless sell dozens of Plasters weekly, but allowing on an average that each only sold *One* every two months, the profits on such sales would be sufficient to pay a dividend of 25 per cent. on the paid-up capital.

We so firmly believe in the immediate success of the proposed Company that we agree to take payment for our interest entirely in Shares, and, further, to take no dividend until all other Shareholders have received at least 10 per cent.

We are desirous to form the Company direct from the public, and to save all expenses of promotion-money, etc. The name of the Company will be

"*The Electro-Magnetic Medical Plaster Company, Limited.*"

Capital £10,000 in 2,000 Shares of £5 each, of which it is proposed to call up only £3—viz., £1 on application, £1 on allotment, and £1 in a month afterwards—or in 10,000 shares of £1 each, as the promoters may determine.

Should you feel disposed to aid in this undertaking, or desire further information, we should be glad if you will communicate with us personally, or by letter, to above address.

A meeting of the respondents to this circular will immediately be called, and steps taken to form the Company forthwith.

Trusting to have a favourable response from you during the current week,

We are, yours faithfully,

WILLIAM WISE } Inventors and
HENRY MILLS } Patentees.

We give also a handbill, circulated by Professor (?) Wise, to obtain customers. What is a "Matteuse"? (See fourth line from end of handbill.) This rubbish, we are told, emanates from "Faraday Institute," Manchester; president, "Professor Wise."

WHAT IS LIFE AND WEALTH WITHOUT HEALTH?

PROFESSOR WISE,

THE EMINENT SPECIALIST,

MEDICAL ELECTRICIAN, AND MANUFACTURER

of all descriptions of Medical Electric Batteries and Appliances,

Has made arrangements for visiting BOLTON every other week, on TUESDAY and FRIDAY Evenings, from 6 to 9.30, at the BOLTON ARMS COFFEE TAVERN, Bradshaw Gate, where he may be consulted FREE OF CHARGE on all Nervous Complaints, such as Rheumatism, Lumbago, Sciatica, Neuralgia, Paralysis, Epilepsy, Sleeplessness, Indigestion, Sluggish Liver, Constipation, Cold Feet, Bad Circulation, Spasms, Toothache, Headache, Asthma, Bronchitis, Diabetes, St. Vitus's Dance, Atrophy or Wasting Muscles, Loss of Nerve Force, and General Nervous Depression.

PROFESSOR WISE has devoted many years of close practical study to Electricity as a Remedial Agent, and to the Manufacture of suitable Batteries, &c., and from the experience he has had in Thousands of Cases of various ailments that have come under his notice, and the high References he has received, he is able confidently to recommend the most suitable Battery and Treatment for Specific complaints.

Nights of Attendance for February.......... 7th 10th
" " " .... 21st 24th

FOR FURTHER ATTENDANCES SEE BOLTON PAPERS.

At the request of several friends, PROFESSOR WISE has arranged to give a Series of

LECTURES ON HEALTH,

with Electric Experiments, &c., in the LARGE ROOM, at the COFFEE TAVERN, as above, commencing—

WEDNESDAY, FEBRUARY 8th, for FEMALES ONLY.
WEDNESDAY, FEBRUARY 15th, for MEN ONLY.

LECTURES TO COMMENCE AT 7.30.

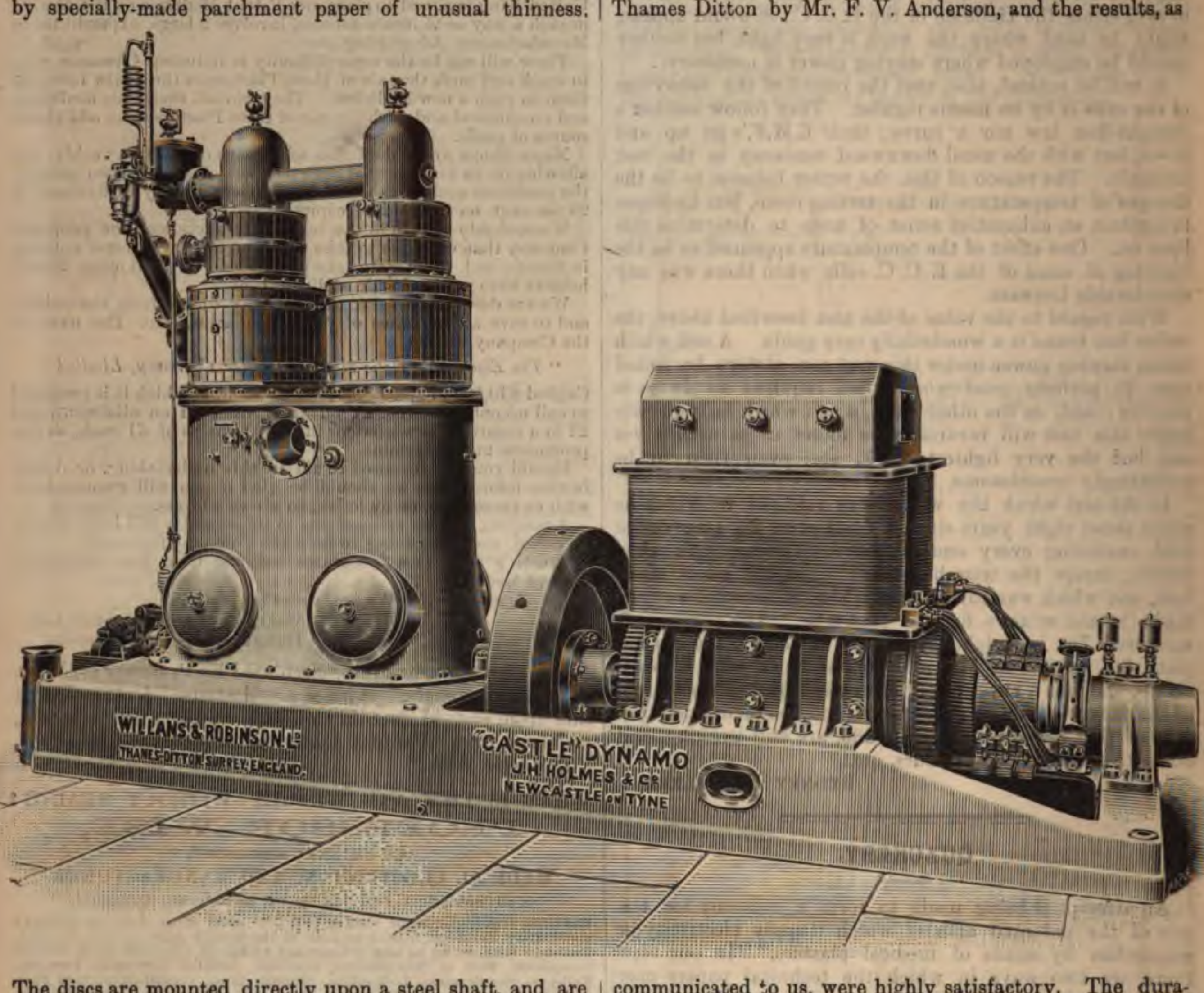
ADMISSION—Sixpence. A few Reserved Seats, One Shilling.

An experienced Lady Electrician and Matteuse will be in attendance nightly to give private consultations, and Treatment to Ladies.

Permanent Address of PROFESSOR WISE, 101, Piccadilly, Manchester,
January, 1893. Where he may be consulted daily from 10 to 5

MESSRS. J. H. HOLMES AND CO.'S NEW "CASTLE" DYNAMO.

On Friday, May 19, a party of engineers representative of the various branches of the profession were the guests of Messrs. Holmes, of Newcastle, at Thames Ditton. The immediate object of the visit was to inspect one of the new "Castle" dynamos of the firm, which had been built for the Aluminium Company, Limited, and brought for exhibition to the works of Messrs. Willans and Robinson. The dynamo in question is of Messrs. Holmes and Co.'s latest improved drum-armature type, wound with bar conductors, and designed for an output of 125 volts and 1,025 amperes, at a speed of 350 revolutions per minute. The over-all dimensions are remarkably small for the output, being only 13ft. by 5ft., but the armature weighs more than two tons. The core is built of about 1,700 thin Swedish charcoal iron discs, carefully insulated from each other by specially-made parchment paper of unusual thinness. The discs are mounted directly upon a steel shaft, and are driven by a key running the entire length of the core, and they are notched in such a manner as to leave three ventilating spaces next the spindle. The bar conductors are built up of copper strips, so split up and twisted as to prevent as much as possible the formation of eddy currents, and they are driven in a positive manner from the core by means of drivers resting in channels at intervals round the periphery. The end crossings, or connections, are made of copper strips of ample cross-section, without joints, arranged in a compact form at each end of the armature, but so as not to interfere with the means of ventilation already referred to. A particular aim in the design has been, of course, to ensure the temperature of the machine being kept as low as possible after long runs, and it will be observed from the tests given below that the makers have satisfactorily attained their object.



The field magnets are of best annealed iron forgings, machined all over, and weigh with their copper windings about eight tons. They are plain shunt wound, and the resistance of the coils is such that at full load about 15 amperes of current flow round the magnets—that is to say, just about 1½ per cent. of the current in the external circuit. The magnets rest upon a brass bed lying on a concrete foundation, and are steadied at the sides by non-magnetic brackets, fixed to Willans patent combination frame, forming the base of the engine, and carrying the outer bearing of the armature. The connections between the armature and the commutator are arranged so as to bring the line of commutation into the horizontal plane with the object of making the brushes and the holders easily accessible. The brushholders are, of course, of large size. The builders claim that the electrical efficiency of their machine is over 97 per cent., so that, deducting for friction and other losses, there is a net commercial efficiency of 94 per cent., and this is said to be maintained over long runs.

It may be mentioned that the dynamo was tested at Thames Ditton by Mr. F. V. Anderson, and the results, as communicated to us, were highly satisfactory. The duration of the test was six hours, the mean speed being 335·7 revolutions per minute, 128·3 volts at the terminals, 1,006 amperes in the external circuit. Hence ($128\cdot3 \times 1{,}006 \div 746$) the electrical horse-power was 173; and the indicated horse-power of the steam-engine having been ascertained to be 201·07, it results that the efficiency of the combined plant is $\frac{173}{201\cdot07} = 86\cdot04$ per cent.

The results of weighing steam showed that 1,400lb. of steam were condensed in 22 minutes 25 seconds, which is equivalent to 3,747lb. per hour. The steam used per electrical horse-power per hour $= \frac{3{,}747}{173} = 21\cdot66$lb.

The results of temperature tests were as follows: Temperature of armature at start, 29·5deg. C.; after six hours run at full load = 57deg. C.; the rise in temperature was therefore 27·5deg. C. Temperature of room at start

23·3deg. C., at finish 26·0deg. C., or a difference of leg. C. The actual rise of temperature in armature due unning of the machine was 27·5 – 2·7 = 24·8deg. C., 14·7deg. F.

Vhen we visited the machine it had been running six rs at full load, and the armature at the commutator end found to be 72deg. F. above the temperature of the osphere. There was no sparking observable, and the kmanship of the machine is certainly all that can be red. It may be stated that it will be shortly handed r to the Aluminium Company, and that its work will he production of sodium by an economical process of trolysis.

MAGNETIC VISCOSITY.*

J. HOPKINSON, D.SC., F.R.S., E. WILSON, AND F. LYDALL.

ne following experiments were carried out in the Siemens oratory, King's College, London, and are a continuation of riments by J. Hopkinson and B. Hopkinson, a description of ch appeared in the *Electrical Engineer*, September 16, 1892.

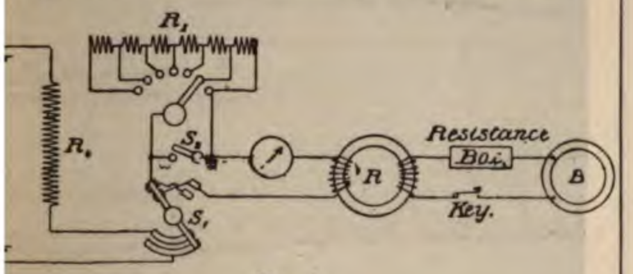


FIG. 1.

that paper determinations were given of curves showing the tion between the induction and the magnetising force for rings ne wire of soft iron and steel, through complete cycles with ing amplitudes of magnetising force. both with the ordinary stic method and with alternating currents of a frequency up to complete periods per second. It was shown that if the induction moderate in amount—for example, 3,000 or 4,000—the two es closely agreed; but if the induction was considerable—for nple, 16,000—the curves differed somewhat, particularly in part of the curve preceding the maximum induction. The rence was greater with steel than with soft iron. It was not determined whether this difference was a true time effect, or in some way due to the ballistic galvanometer. The present r is addressed to settling this point.

ne ring to which the following experiments refer is of hard l, containing about 0·6 per cent. of carbon, in the form of wire n. diameter, varnished with shellac to ensure insulation. The erial was supplied by Messrs. Richard Johnson. The ring is about diameter, and has a sectional area of 1·08 square centimetre. wound with 200 turns of copper wire, and with 80 turns of wire for use with the ballistic galvanometer. In the *Electrical ineer* paper the static curve of hysteresis was determined by ballistic galvanometer, the connections being made according the diagram in Fig. 1, where R is the hard steel wire , B is the ballistic galvanometer, S_1 is a reversing switch, and a small short-circuiting switch for the purpose of suddenly rting a resistance, R_1, into the primary circuit. The resist- R_2 was so adjusted that the maximum current in the ary circuit was such as to give the desired maximum magnetis- force on the ring. In taking the kicks on the ballistic anometer the method adopted was as follows: Having closed primary by means of S_1, the switch S_2 was suddenly opened, allowing the magnetising force to drop to an amount deter- ed by R_1, and the kick observed. A total reversal was then n with S_1, and the kick again observed. The closing of S_2 n brought up the magnetising force to its maximum in the osite direction to that at starting.

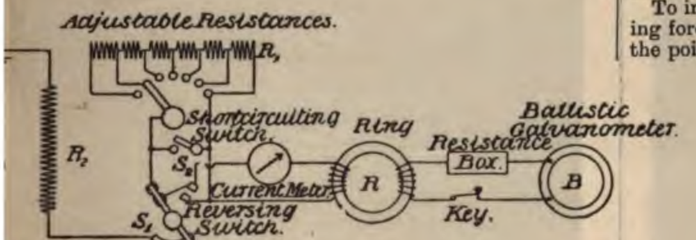
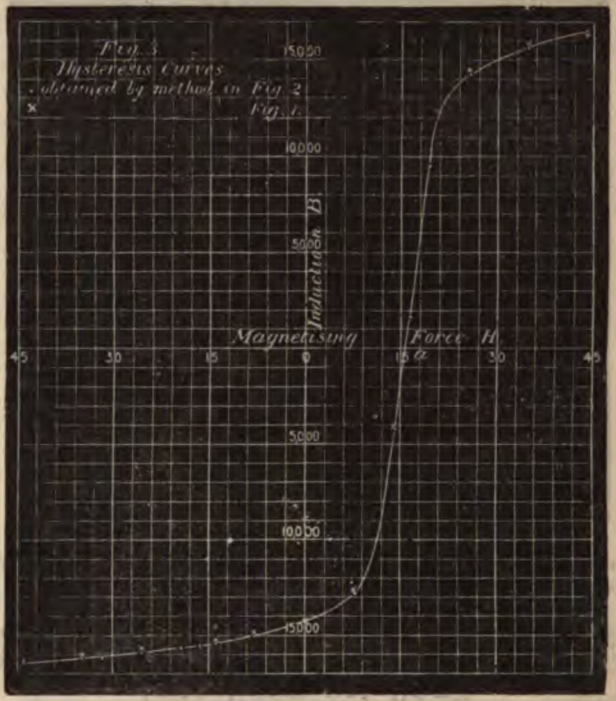


FIG. 2.

In a letter Mr. Evershed stated that "Had the slow cycle been obtained by the method described by Mr. Vignoles, Messrs. Hopkinson would have found it in almost absolute agreement with the quick cycle curve." To settle this point the static curve of hysteresis was obtained by the ballistic galvanometer, the connections being made according to the diagram in Fig. 2. This is not the method of experiment alluded to by Mr. Evershed, but it is capable of varying the magnetising force in the same way as is described by him. R is the hard steel wire ring, B is the ballistic galvanometer, S_1 is a reversing switch, and S_2 a small switch for the purpose of short-circuiting the adjustable resistance, R_1. The difference between this diagram and that in Fig. 1 is that R_1 can be suddenly inserted into the primary circuit by one stroke of the reversing switch, S_1. In this way it is possible to vary the magnetising force from one maximum through zero to any desired point within the other maximum by one motion of the switch S_1, which operation takes but a small fraction of a second to perform.



In Fig. 3 the points marked × were obtained by the method in Fig. 1; the points marked · being obtained by the method in Fig. 2. Table I. gives the values for B and H, from which these points have been plotted, and their close agreement proves that the difference found between the static and quick cycle curves is not due to the cause suggested by Mr. Evershed. In each case the battery used had a potential difference of 108 volts, the periodic time of the ballistic needle being 10 seconds. It was observed, when taking the hysteresis curve by the method in Fig. 2, that the sum of the inductions found by varying the magnetising force from one maximum to an intermediate point, and from that point to the other maximum, did not exactly equal the induction got by varying the magnetising force direct from one maximum to the other.

To investigate this with the ballistic galvanometer the magnetising force, Fig. 3, was taken from one maximum through zero to the point *a*, by one motion of the reversing switch handle, and the galvanometer circuit closed at known intervals of time after such change, the deflection being noted. This deflection does not represent an impulsive E.M.F., nor yet a constant current, but is caused by a current through the galvanometer diminishing in amount somewhat rapidly. It might arise from the comparatively slow rate at which the magnetising current changes, owing to the self-induction of the circuit, or it might arise from a finite time required to develop the induction corresponding to a given magnetising force. The former would be readily calculable if the ring had a definite self-induction; in our case it is approximately calculable.

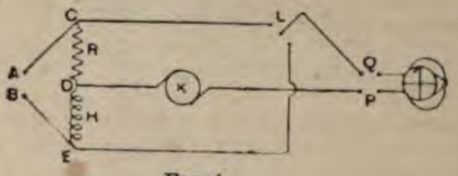


FIG. 4.

Let R be resistance of primary circuit, E the applied E.M.F., x the current, and I the total induction multiplied by the number of primary turns.

$$E = Rx + \frac{dI}{dt}.$$

Now I is known in terms of x for conditions of experiment very approximately, and roughly dI/dt has a constant ratio to dx/dt—

Paper read before the Royal Society.

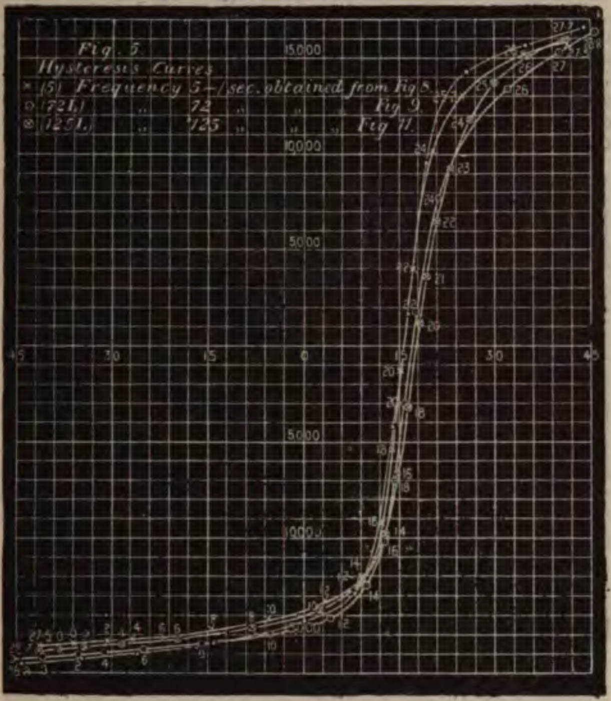
is equal, say, to L (dx/dt); hence the well-known equation

$$E = Rx + L\frac{dx}{dt},$$

$$x = \frac{E}{R}\left(1 - \epsilon^{-\frac{R}{L}t}\right).$$

From our curves we see that induction per square centimetre increases 10,000, whilst magnetising force increases 4. Total induction multiplied by the primary turns, taking the volt as our unit, increases $10{,}800 \times 200 \times 10^{-8}$, whilst the current increases half an ampere—*i.e.*,

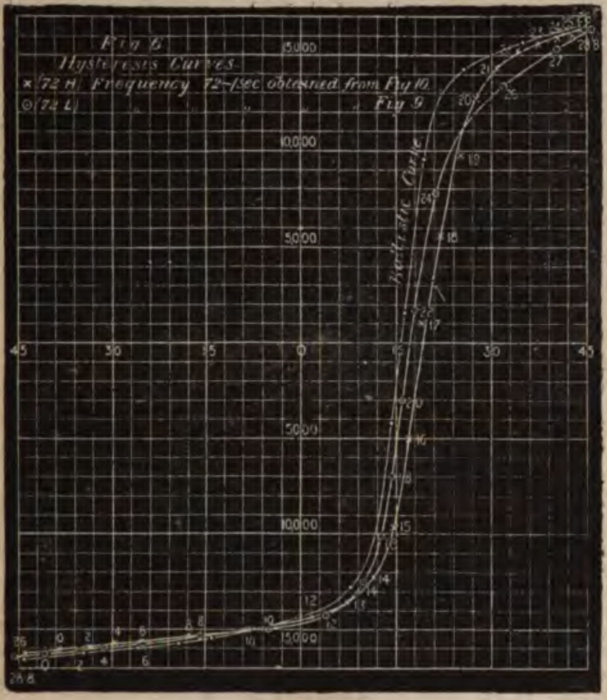
$$L = 4{\cdot}32 \times 10^{-2}.$$



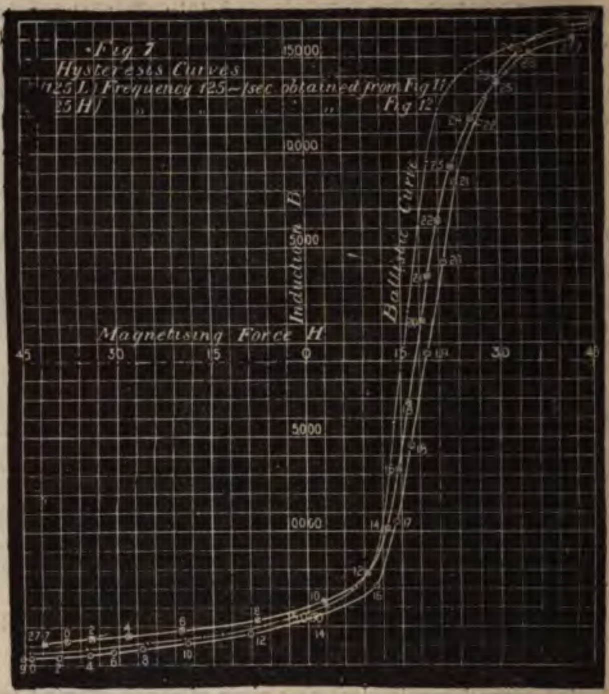
In the experiments made E = 4 and 108 volts and R = 0·8 and 21·6 ohms, whence

$$x = 5\,\left(1-\epsilon^{\frac{80}{4\cdot32}t}\right) \text{ and } 5\,\left(1-\epsilon^{\frac{2160}{4\cdot32}t}\right).$$

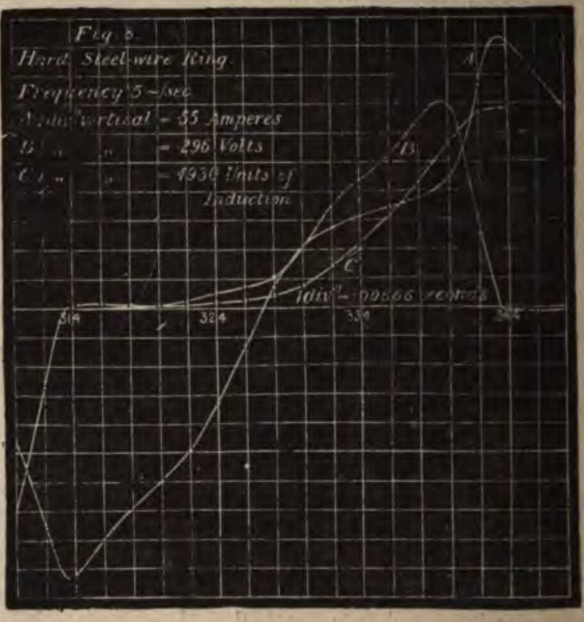
In either case x does not differ sensibly from its final value when $t = \frac{3}{5}$ second. Hence the self-induction of the circuit can have nothing to do with the residual effects observed. These experiments showed that an effect was produced upon the galvanometer needle, appreciable for some seconds, the effect being somewhat more marked with 4 than with 108 volts. But the whole amount was so small as to be less than 1 per cent. of the total change of induction; from which we infer that no material difference exists *between curves of* induction determined by the ballistic galvanometer *and the inductions caused* by magnetising forces operating *for many seconds.*



Effect of Tapping the Specimen.—Having taken the magnetising force from its maximum through zero to the point *a* as before, the effect of tapping was marked, especially in the case of soft iron, when a kick corresponding to an acquirement of 633 lines of induction per square centimetre was observed. The following experiments on the hard steel wire ring were carried out with the alternator, the object being to ascertain if a time effect on magnetism exists. The ballistic curve, Fig. 3, has been taken as a standard with which to compare the respective hysteresis curves.

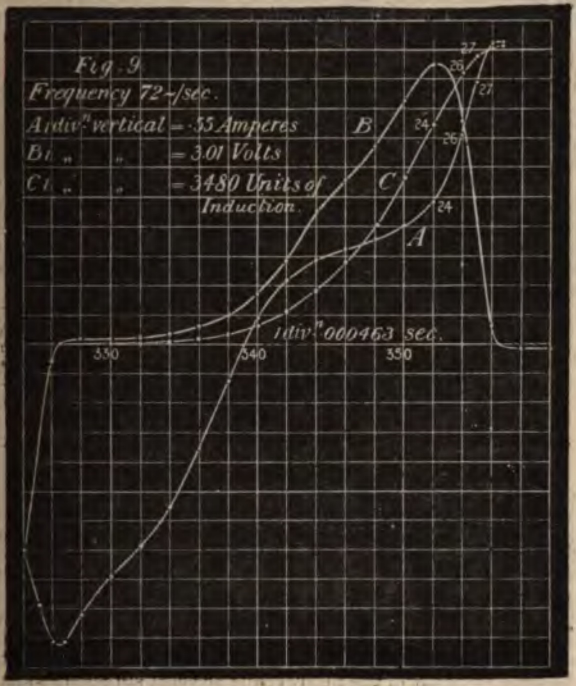


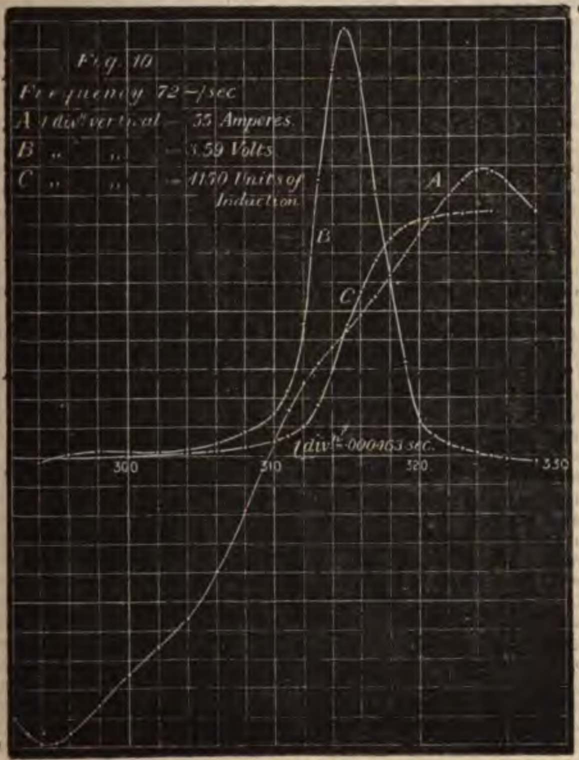
In each case the maximum magnetising force has been made as nearly as possible to agree with that used when taking the ballistic curve, and the method of test was that employed in the *Electrical Engineer* paper. For the sake of completeness, the diagram, Fig. 4. and description are given over again. Quoting from that paper, we have: "For determining the points on the closed curve of magnetisation given by rapid reversals of the current in the coil, the ring was connected in series with a non-inductive resistance to the poles of an alternate-current generator, or a transformer excited by the generator, Fig. 41, in which A B are the poles of the transformer or generator; C D the terminals of the non-inductive resistance, R; H the coil surrounding the ring; P and Q the studs of a reversing key connected to the quadrant of a Thomson quadrant electrometer; L a key by means of which Q could be connected with C or E at will; and K a revolving contact-maker, through which P was connected to D. A condenser was connected to P and Q in order to steady the electrometer readings. The contact-maker, K, was bolted on to the axle of the generator. It consists of a circular disc of ebonite, about 13in. in diameter, having a small slip of copper, about $\frac{1}{16}$in. wide, let into its circumference. A small steel brush presses on the circumference, and makes contact with the piece of copper



once in every revolution. The position of the brush can be read off on a graduated circle. The quadrant electrometer thus gives the instantaneous value of the difference of potential between the points C and D, or the points D and E, according to the direction of the key L."

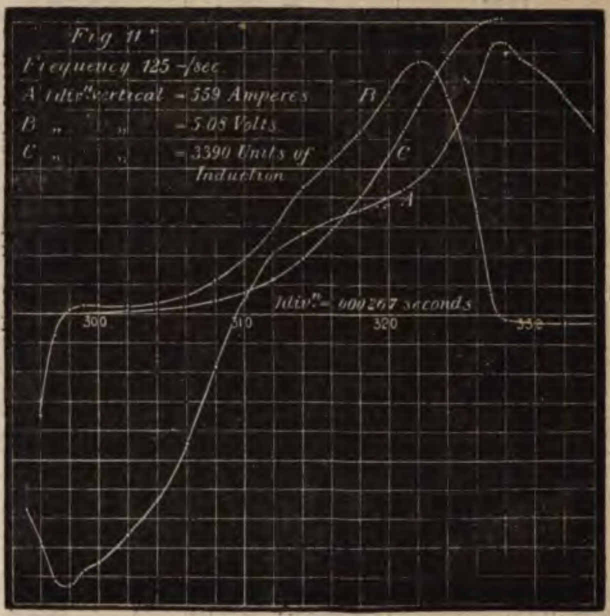
Frequencies of 5, 72, and 125 ⁀‿ per second have been tried, two values being given to the potential difference at the terminals of the alternator in each of the frequencies 72 and 125, making in all five complete experiments. The curves so obtained are given in Figs. 8, 9, 10, 11, and 12 respectively. From observations of the values of the E.M.F. between C and D, Fig. 4, at different times in the period, a curve, A (in each experiment) was plotted, giving the magnetising force in terms of the time; a similar curve was plotted for the E.M.F. between D and E, which, when corrected by subtracting the E.M.F. due to the resistance of the coil, H, gives the potential or time rate of variation of the induction in terms of the time. Hence the area of this curve, B, up to any point, plus a constant, is proportional to the induction corresponding to that point. This is shown in curve C, which is the integral of B. In each of the five experiments the ring with the non-inductive resistance was placed across the terminals of the alternator, and the excess of potential taken up by a non-inductive resistance.





In Fig. 5 the hysteresis curves for frequencies of 5, 72, and 125 are compared with the ballistic curve. These curves are marked 5, 72L, and 125L respectively. The corresponding values for B and H, from which these curves have been plotted, are given in Tables II., III., V., which have been obtained from the curves in Figs. 8, 9, and 11 respectively.

The most noteworthy features in these curves are that the curve with a frequency of 5 is very near the ballistic curve, if allowance is made for difference in the magnetising current, and that the curves with a frequency of 72 and 125 deviate very materially, particularly in the part of the curve somewhat preceding the maximum induction. Hence the time effect mainly develops with a greater frequency than five per second. Hence also we infer that this effect, as already described in the *Electrical Engineer*, is a true time effect, not rising in any way from the ballistic galvanometer.



In Fig. 6 the hysteresis curves for a frequency of 72 are compared with the ballistic curve. The curves are marked 72L and 72H respectively, the potentials at the terminals of the alternator in the two cases being approximately 36 and 430 volts. The corresponding values for B and H are given in Tables III. and IV., which have been obtained from the curves in Figs. 9 and 10 respectively. The difference between the two curves in Fig. 6 was at first puzzling, but a little consideration satisfied us that it arises from the same time effect. The curve 72L was determined three times, with the same result. The numerals refer to thirtieths of a half period. From 26 to 28·8 of the L curve the magne-

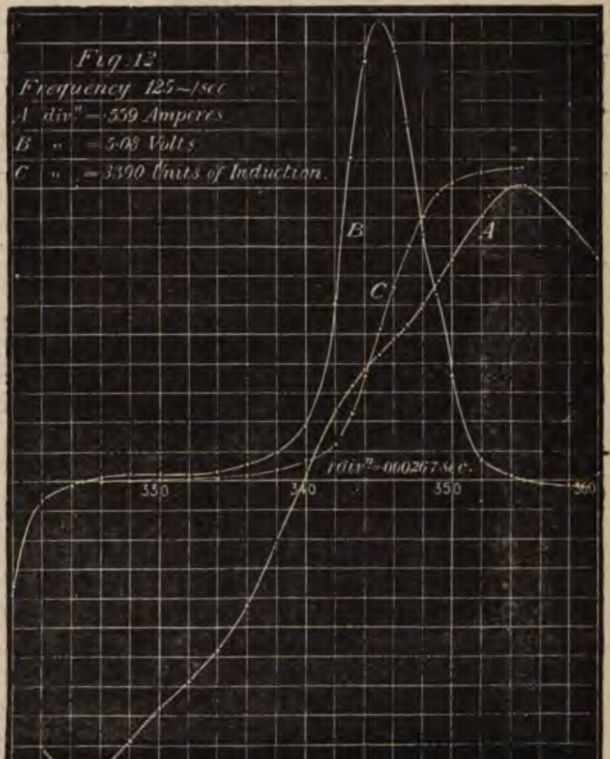


Table I.—Hard Steel Wire Ring.

H.	B.	
	Points marked × obtained by method shown in Fig. 1.	Points marked • obtained by method shown in Fig. 2.
+ 44·12	16,295	16,436
34·77	15,830	15,650
25·44	+ 14,407	14,290
19·32	—	9,539
16·1	—	+ 1,704
14·2	- 4,045	- 4,130
7·73	12,690	12,820
0	—	14.280
- 7·73	14,870	14,990
14·2	12,270	15,380
16·1	—	15,460
19·32	—	15,630
25·44	15,733	15,860
34·77	16,033	16,150
44·12	16,295	16,436

Table II.—Frequency, 5 per second. Table III.—Frequency, 72 per second. Potential at terminals of alternator, approximately 36 volts.

Table II.		Table III.	
B.	H.	B.	H.
15,660	41·7	16,245	+45·7
15,200	34·4	16,180	45·5
13,010	25·1	15.215	39·9
10,190	19·95	13,410	31·7
+ 3,970	17·1	7,805	21·3
- 1,230	15·3	+ 1,805	17·8
5,340	14·1	- 3,030	15·8
9,176	12·3	7,027	14·3
12,007	9·4	10,121	12·6
13,377	+ 3·4	12,506	9·86
14,382	- 5·6	14,118	4·26
14,747	14·4	14,956	- 5·44
15,203	22·0	15,407	15·86
15,295	26·85	15,729	24·77
15,477	30·86	15,923	31·1
15,523	35·75	16,116	35·4
15,660	41·7	16,219	40·9
—	—	16,245	45·7

Table IV.—Frequency, 72 per second. Potential at terminals of alternator, approximately 430 volts. Table V.—Frequency, 125 per second. Potential at terminals of alternator, approximately 62 volts. Table VI.—Frequency, 125 per second. Potential at terminals of alternator, approximately 750 volts.

Table IV.		Table V.		Table VI.	
B.	H.	B.	H.	B.	H.
16,221	43·98	15,936	+41·74	16,689	+45·0
16,214	44·32	15,746	40·95	16,671	44·65
16,069	42·75	15,119	35·00	16,565	40·72
15,919	40·61	13,739	30·07	15,311	33·66
15,685	37·25	11,732	26·48	13,930	30·18
15,299	34·33	9,222	23·11	11,544	27·15
14,299	30·97	6,462	20·87	8,411	23·78
12,689	27·6	3,576	19·19	+ 4,077	21·54
9,839	24·91	+ 1,192	18·18	- 565	19·30
5,539	21·88	- 3,136	16·16	5,396	16·83
+ 999	19·3	6,776	14·59	9,474	14·36
- 5,073	16·6	9,850	12·57	12,862	10·77
9,609	14·36	12,172	9·20	14,368	1·12
12,300	11·22	13,615	2·24	15,309	- 9·20
13,530	7·18	14,618	- 8·08	15,873	18·85
14,145	+ 2·24	15,120	19·75	16,099	26·25
14,999	- 8·08	15,434	28·61	16,262	30·63
15,452	17·72	15,622	34·10	16,413	34·33
15,644	25·13	15,773	38·37	16,564	39·49
15,814	29·62	15,936	41·74	16,670	43·98
15,914	33·66	—	—	16,689	45·10
16,122	38·37	—	—	—	—
16,221	43·98	—	—	—	—

tising force increases from 31·8 to 45·6, whilst from 21 to 26 of the H curve it increases from 30·6 to 44, the rate of change being about double as great in the former case as in the latter, and it is the L curve which deviates most from the ballistic curve. In like manner, in the neighbourhood of zero induction, the induction in the H curve is changing twice as fast as the induction of the L curve, and it is here the H curve which *differs most.* How these differences of rate of change arise can be *seen by inspecting Figs. 9 and 1C.*

In Fig. 7 the hysteresis curves for a frequency of 125 are compared with the ballistic curve. The curves are marked 125L and 125H respectively, the potentials at the terminals of the alternator being approximately 62 and 750 volts. The corresponding values for B and H are given in Tables V. and VI., which have been obtained from the curves in Figs. 11 and 12 respectively. These curves show the same difference as Fig. 6, but less markedly than in Fig. 5. The L curve was determined twice.

Experiments have been made upon chromium steel, supplied by Mr. Hadfield, having the following composition: 0·71 per cent. carbon, 9·18 per cent. chromium, when annealed, and when hardened by raising to low yellow and plunging into cold water. The results show that the same time effect exists in this case, although it was not so marked as in the case of the hard steel.

We draw the following conclusions from these experiments: 1. As Prof. Ewing has already observed, after sudden change of magnetising force, the induction does not at once attain to its full value, but there is a slight increase going on for some seconds. 2. The small difference between the ballistic curve of magnetisation with complete cycles and the curve determined with a considerable frequency, which has already been observed, is a true time effect, the difference being greater between a frequency of 72 per second and 5 per second than between 5 per second and the ballistic curve.

COMPANIES' REPORTS.

TELEPHONE COMPANY OF IRELAND, LIMITED.

The following is the report of the Directors of the Telephone Company of Ireland, Limited, to be presented at the fourteenth ordinary general meeting of the proprietors, to be held at the offices of the Company, Commercial-buildings, Dublin, on the 27th of May.

The Directors present their report and statement of accounts for the year ended December 31, 1892. The development of the business of the Company continued during the year, there being at the close of the year an increase of 63 subscribers as compared with the corresponding period of the preceding year, while the accounts show a balance to credit of the net revenue account sufficient to pay the arrears of dividend upon preference shares, and a small dividend on the ordinary shares. Having regard, however, to the absolute necessity for the continuance of a large expenditure on capital account, the Directors are unable to recommend that any portion of the earnings should be distributed among the shareholders. Besides the outlay of capital requisite in order to meet the development of the business which may be expected on the completion of the Post Office trunk service, the progress made in telephony necessitates the renewal of the entire of the internal arrangements of the Company's exchanges in Dublin, Cork, Limerick, Dundalk, and Drogheda, and the replacement of the present switchboards by others of the latest construction, while on the outdoor works a large capital expenditure is also absolutely required, hence the balance to credit of the revenue account, and for some time the future profits of the Company should, if the Company continued its operations and unless the shareholders provided the further necessary funds, be expended on capital account. In view of this fact and of the fact that the preference shares offered in January, 1890, or even the debentures offered in July, 1890, were not taken up by the shareholders, and that the Directors were obliged, in order to obtain a subscription for the debentures, to incur the large expense stated in the accounts for the year 1891, the Directors, while the working of the Company shows such favourable results, were forced to the opinion that an amalgamation with the National Telephone Company, on fair terms, would be most to the advantage of the shareholders in this Company. Accordingly, after somewhat protracted negotiations, an agreement for amalgamation has been entered into between this Company and the National Company, subject to the sanction of the shareholders of this Company. By this agreement the National Company agrees to pay, as of the 31st December last, the sum of £81,300 for the entire assets of this Company. The National Company waives any claim to participate in the assets of this Company in respect of the moiety of the ordinary share capital to which they are entitled. These terms the Directors consider fair, and, under the circumstances, advantageous to the shareholders of this Company. After paying off the debentures (£15,000) and the preference share capital (£46,197) there would remain for division among the ordinary shareholders the sum of £20,103. This, however, would be subject to the claims of the preference shareholders for arrears of preference dividend to 31st December last, and to the necessary expenses of liquidating this Company. A very large proportion of the holders of the preference shares have assented to the amalgamation with the National Company, conditional upon their receiving 20s. per share in full discharge of principal and arrears of dividend. Under the agreement with the National Company the interest upon the debentures and the dividend upon the preference shares accruing since 1st January last up to the date of the completion of the agreement are to be paid by that company. This agreement will be submitted to the general meeting which has been convened, and the Directors recommend it to the approval of the shareholders. The agreement may be inspected previous to the meeting at the office of the Company. One of the Directors, Alderman V. B. Dillon, jun., retires at this meeting, in conformity with the articles of association, but is eligible for re-election. The auditor, Mr. John M. Kean, also retires, but is eligible for re-election.

NEW COMPANIES REGISTERED.

Coventry Electric Tramways Company, Limited.—This Company has been registered by R. B. Johnson, 49 and 50, Parliament-street, S.W., with a capital of £25,000 in £5 shares. Object: to carry into effect an agreement, made May 5, between the Electric and General Contract Corporation, Limited, of the one part, and A. G. Jones, on behalf of this Company, of the other part, for the acquisition of certain property, and to work and turn to account electric tramways at Coventry and elsewhere. Table A mainly applies.

Perkins and Bellamy, Limited.—Registered by Roper and Whateley, 17, Lincoln's-inn-fields, W.C. Capital £70,000, divided into 2,000 £6 per cent. cumulative preference and 5,000 ordinary shares of £10 each. Objects: to acquire, take over as a going concern, and carry on the business of agricultural engineers, iron merchants, ironmongers, builders, contractors, and electrical engineers now carried on under the style or firm of Perkins and Bellamy, at Ross, Herefordshire, and with a view to adopt and carry into effect the agreement referred to in clause 4 of the articles of association to be made between Ann Elizabeth Perkins, widow, and George Shead, the trustees of the will of Henry Perkins, deceased, and Thomas Henry Bellamy, thereinafter called the vendors, of the one part, and Frederick W. Wintle, on behalf of the Company, of the other part. Signatories:

	Shares.
William R. Rootes, Bank Offices, Ross	1
James Meredith, 2, Market-place, Ross	1
Frederick W. Wintle, Bank Offices, Ross	1
Thomas H. Bellamy, Bank House, Ross	1
George Shead, 18, Laurence Pountney-hill, E.C.	1
Francis A. Walrond, 41, Ladbroke-grove-road, W.	1
Hubert C. Owen, 18, King's Arm's-yard, E.C.	1

There shall not be less than two nor more than five directors. The first are William R. Rootes, James Meredith, George Shead, and Thomas H. Bellamy. Qualification, £250. Remuneration, £50 each per annum.

BUSINESS NOTES.

Bury.—We understand that preliminary tenders are to be asked for almost immediately.

Bank-Lighting.—Messrs. Drake and Gorham are fitting up an electric light installation for the Union Bank, Chancery-lane.

Madras.—The Electric Construction Corporation have taken a contract for an electric tramway in Madras, India, which will be 15 miles long.

Bournemouth Fire Alarms.—The Bournemouth surveyor has been instructed to prepare a scheme by which calls given should be answered by the firemen.

Australia.—The address of the Crompton Electric Supply Company of Australia is now 193, Clarence-street, Sydney. Mr. K. H. Buchanan is manager.

West India and Panama Cable.—The receipts of the West India and Panama Telegraph Company for the half-month ended May 15 were £4,000, against £2,663, an increase of £1,337.

Norwich.—At the meeting of the Norwich Town Council last week, Mr. Henry Curl suggested that steps should be taken to make arrangements for public lighting with the electric lighting company.

Change of Name.—The Electricity Supply Corporation, Limited, has, with the sanction of the Board of Trade, changed its name to "The Charing Cross and Strand Electricity Supply Corporation, Limited."

Western and Brazilian Telegraph.—The receipts of the Western and Brazilian Telegraph Company for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,680.

Leicester.—The Midland Railway have ordered of the Dowson Gas Company, 3, Great Queen-street, S.W., a set of Dowson gas plant for lighting the new station at Leicester, for about 200 b.h.p., to drive Crossley engines.

Thomson-Houston Railways in France.—The Thomson-Houston system is to be adopted for electric tramways in Bordeaux. The company is also in negotiation for equipping an important town near Paris.

Madrid Tramways.—A tramway is being built from Madrid to Barrio de la Prospendad, a suburb. *Industries* hears that the Allgemeine Company are doing their best to persuade the company to run the line by electricity.

Holloway Station.—The Great Northern Railway Company have accepted the tender of Messrs. Johnson and Phillips for the supply of Brockie-Pell arc lamps and accessories for their Holloway electric light station.

National Telephone Debentures.—Letters of allotment and regret have been posted by the National Telephone Company, Limited, in respect of £273,523 4½ per cent. debenture stock offered to the ordinary shareholders of the Company.

Removal.—Messrs. Johnstone, Benjamin, and Co., manufacturers of electrical insulated wires, wire coverers, drawers, and metal merchants, have removed from Balmer-road, Bow, to 3, Wenlock-road, and 12A, Edward street, City-road, E.C.

City and South London Railway Company.—The receipts for the week ending May 21 were £794, against £766 for the same period last year, or an increase of £28. The total receipts for 1893 show an increase of £1,361 over those for the corresponding period of 1892.

Powderhall (Edinburgh).—At a meeting of the Cleaning and Lighting Committee of the Edinburgh Town Council, held on Monday, an estimate amounting to £350 was accepted for an installation of electric light at the new Powderhall destructor buildings.

Wolverhampton.—The Wolverhampton Electric Lighting Committee have selected from a large number of candidates Mr. Baynes, of Bradford, and Mr. Lewis, of Hull, for the appointment of electrical engineer, and will make a final selection from those two gentlemen.

Medal.—The Sir John Pender gold medal has been awarded to Mr. David A. Ramsay, diploma student of the Glasgow and West of Scotland Technical College, after a three years' course in Prof. Jamieson's electrical laboratory and the various other classes requisite for the diploma course.

Doncaster.—Local papers are asking: When is Doncaster going to have the electric light? While China and Japan revel in electric luxuries, "in Doncaster the installation of the electric light in one or two business establishments has been of such recent occurrence that it has hardly yet ceased to be a wonder."

Chiswick.—At the meeting of the Chiswick Local Board last week, the clerk reported that he had received the memorandum and articles of association of the Bourne and Grant Electricity Company, Limited. The company had been registered, and the secretary was Mr. R. G. H. Atkins. The registered offices were in George-street, Mansion House.

Coatbridge.—The Scottish House-to-House Electric Lighting Company have feued a piece of land in Dundyvan for the purpose of laying down electric lighting plant for Coatbridge, and have obtained the necessary sanction to open up the pavements of certain streets for laying down their main wires. The company have contracted with the Brush Electrical Company to carry out the work, and operations will begin at once.

Goodrich Court.—Last Friday evening, in compliance with an expressed wish, Mr. and Mrs. H. C. Moffatt, of Goodrich Court, Monmouth, invited the workmen engaged in the recent alterations and improvements on the estate, together with their wives, to see the grand hall at the Court lit up with the electric light. The visitors, who were numerous, were much pleased and gratified with the brilliant illumination, which was very effective.

Deputations.—The Fleetwood Electric Lighting Committee are to go a four days' trip in the South to visit Bath, Bournemouth, and London, and so gain experience on the practical side of town electric lighting. An electric light firm is understood to be standing the entire expense, and the opinion is expressed that ratepayers ought to be very thankful to them for allowing the committee to go the tour without coming to the rates for a penny.

Atlantic Liners.—The White Star Line have ordered a new steamer 800ft. long for the Atlantic service. Messrs. Harland and Wolff, of Belfast, are the builders, and their representative is confident they will beat anything in the way of speed yet attained. They are of the opinion that speed cannot be much further increased as long as steam is the motive power, but express the opinion that electricity in the near future may achieve great things in this respect.

Dover.—The Town Clerk of Dover explained at the last Town Council meeting that he had been to the Board of Trade with a representative of the Brush Electric Lighting Company, and a satisfactory settlement of all points had been made, but as the time for commencing operations had expired a further extension was asked for of three months from July 1. The Mayor pointed out that the company must commence operations within five months, or the arrangement falls through.

Communication with Lighthouses.—The Press Association states that the Royal Commission to enquire into communication by telegraph between lighthouses and lightships around the coast with the shore will commence another tour of inspection in one of her Majesty's despatch vessels early in July. It is intended to start on the east coast of Scotland, and travel northwards, visiting any lightships and lighthouses on the north and west coasts. The commission will go to the Isle of Man, and thence to the north coast of Ireland.

Northampton.—The Stockport Corporation Town Hall Committee visited Northampton to inspect the town hall buildings last week. The visitors were very favourably impressed with the convenient arrangements of the municipal departments under one roof, including the entire police and fire brigade equipment. The building, which cost about £70,000, is of very imposing dimensions, and was erected about a year and a half ago. The electric light is used pretty well all over, even the police cells being lighted by electricity in a manner which prevents prisoners interfering with it.

Taunton.—A Bill to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, came on before the examiners of the House of Commons on Thursday last week, for proof of compliance with the standing orders. Among others was one enabling the Corporation of Taunton to supply electricity within the borough and a portion of the district of the Taunton Rural Sanitary Authority. There was no opposition at the stage, and the necessary formal proofs having been given, the Bill was ordered to be reported for second reading.

Watford.—At the meeting of the Watford Local Board last week the Clerk said he would like the Board to decide whether they would apply for a provisional order or only for a license. A license only lasted for seven years, whereas a provisional order lasted for an unlimited period. The former could be obtained almost at once, whereas the latter could not come in force for about a year. The license would answer practically the same purpose, but at the end of seven years they would have to apply for the renewal of the license. After discussion it was agreed that the Board should apply for a provisional order.

Ireland.—It is announced that the directors of the General Electrical Engineering Company of Ireland have decided to wind up the concern owing to want of capital, and other causes not specified. Messrs. Woodhouse and Rawson are also closing their Dublin branch, and are offering the plant in stock at reduced prices. On the other hand, the Edison and Swan Company are opening extensive premises in Dawson-street as showrooms, where they expect to do a good business in the sale of lamps, etc., Mr. Boucher, who was lately on the staff of Messrs. Gordon and Co. being appointed their representative in Ireland.

Aberdeen Mechanical Society.—A special meeting of the Aberdeen Mechanical Society was held recently—Mr. Esson, the president, presiding—to hear the prize winners in the associates' competition read their papers. There were three prize papers, two of the prizes being presented by the society, and one by Mr. Coutts, of Messrs. M'Kinnon and Co. The prize winners were Mr. Alexander Stewart, for a paper on "The Lathe and its Uses"; Mr. William Smith, for a paper on "Electric Lighting"; and Mr. Richard S. Allen, for a paper on "The Transmission of Power." A discussion followed the reading of each paper, and the associates were congratulated on the results of their work.

Morecambe.—The Morecambe Electric Light and Power Company, Limited, is a flourishing concern. The company, which was floated in October, 1891, commenced operations in April, 1892, and during its first season supplied 1,200 lamps to the principal tradespeople, the hotels, the Winter Gardens, and other places of amusement. It is now supplying about 2,500 lamps. The power is obtained from a Dowson gas-engine, supplied by Dowson gas, a plan which claims to have solved the problem of supplying electric light for limited instalments on a profitable basis and at a popular price. This contention was supported by the result of the first season's working, for a dividend of 5 per cent. was paid, and the subscribed capital now only amounts to a little under £4,500. The electric light is not yet in use in private houses, but there is every prospect of its being adopted in the new dwellings that are now being erected, and a proposal is now under consideration for utilising it for public lighting on the promenade.

Electrical Trades Society at Wolverhampton.—At the meeting of the Wolverhampton branch of the Electrical Trades Society last Saturday, Mr. Collins gave an address on "Trade Societies: Their Failure and Success," during which he referred to the local branch of the Electrical Society. Mr. Parker, he said, had worked excellently with his men. He had done numerous good deeds for his workpeople, and they that night wished to recognise his worth. In reply to the toast of his health, which was drunk with musical honours, Mr. Parker said it was a good deal owing to their united efforts that the trade in which they were engaged had been made a large one. Wolverhampton had not properly woke up to the vast value of the electrical business to the town; it had behaved as sleepily in this matter as it did with respect to the bicycle business. He desired his men to be careful as to how they disposed of their spare hours, and to study those subjects of science which were of use in relationship to their business, for it would be a pleasure to him to see working-men taking up good positions in the electrical trade. There were hundreds of things yet to be invented in the business, some of which they themselves, by patient study and steady application of their minds, might be able to patent. The interests of employers and employed were closely allied, and there was for workmen a big patrimony when they would take it.

Electric Traction v. Telephones.—The report of the Parliamentary Committee of the London County Council, May 16, 1893, on electric traction (protective clauses) has the following minute: "We understand that a joint committee of both Houses is to be appointed to consider the subject of electric traction. There have been several discussions before the Board of Trade and committees of Parliament as to whether any, and if so, what form of protection should be given to the telephone company in the case of Bills authorising use of electricity either for lighting purposes or for motive power. It appears to be admitted that telephone wires constructed and worked on the principle commonly followed by the National Telephone Company are liable to be interfered with by induction as a result of the use of electricity for other purposes in the neighbourhood. The telephone company claim in such cases a clause which, while reserving their position, would place those using electricity for other purposes under considerable obligations in order to provide against possible induction. The decisions of the Board of Trade and of the committees have varied, and the appointment of a select committee to consider the whole question has become necessary, and as the Council is interested in the matter in regard to electric lighting, and possibly may be hereafter in regard to tramways which it may be desired to work by electricity, we recommend that the Council do give instructions that it be represented before the joint committee." It was resolved that the recommendation of the committee be adopted.

Hove.—At the meeting of the Hove Commissioners last week, the Town Hall Committee reported that they had given further consideration to the designs and offers sent in for wiring and providing fittings for lighting the Town Hall and offices by electricity, and recommended that the Board should apply to the Local Government Board for sanction to borrow £1,400 to cover the cost of the work. In moving the confirmation of the committee's proceedings, Mr. Woodman stated that in inviting tenders for this work a somewhat unusual course was pursued, people being invited to send in their own schemes as well as their own prices, instead of tendering a price for carrying out work according to a settled specification. Altogether, 15 tenders and 15 schemes were received in answer to their advertisements. An expert, Mr. King, of Westminster, who was called in to assist the committee, advised them that two schemes only—those by Messrs. Strome and Co., and Messrs. Crompton and Co.—were worthy of the committee's consideration. The committee would arrive at a final decision at their next meeting, and in order to save time they had come to the conclusion that they would recommend the Board to apply for sanction to borrow £1,400 at once, the prices of the two tenders being both a little under that amount. Mr. A. G. Henriques moved to except this part of the proceedings, so that more information might be laid before them, but the amendment was negatived by 23 votes to 7. Subsequently Mr. J. Woodman stated, with regard to the progress of the electric lighting in Hove, that the length of streets now completed by the company was 27,510ft., or a little over five miles, within the compulsory area, as well as 11,075ft. in Lansdowne-road, Cambridge-road, and Western road.

Prices at Scarborough.—The Scarborough Electric Supply Company, Limited, has provisionally fixed the following rate of charges: The company's standard charge for electrical energy will be 7d. per Board of Trade unit. In addition, the charge for meter rent will be 2s. per quarter for any number not exceeding 50 8-c.p. 35-watt lamps connected, and 6d. additional per quarter for every 25 such lamps connected. A cash discount of 5 per cent. will be allowed on all quarterly accounts if paid within 14 days. Customers will further be entitled to a rebate (to be deducted from the last quarterly payment in each year) based upon the total number of 8-c.p. 35-watt lamps (or their equivalent) that they have fixed, and the average number of hours per annum that the lamps are burnt, calculated according to the following table:

—		Per cent. rebate according to average number of hours burnt per annum.															
		500	550	600	650	700	750	800	850	900	950	1000	1100	1200	1300	1400	1500
Number of 8-c.p. 35-watt lamps (or their equivalent) fixed.	25..	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	50..	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	100..	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	200..	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	300..	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	400..	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	500..	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	750..	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20
	1 000..	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20	20

Popular Electricity at Portsmouth.—The Electric Lighting Committee of the Portsmouth Town Council have just intimated publicly that it is hoped that by the autumn of the present year the Corporation will be in a position to supply electric energy to private consumers for lighting, heating, and ventilating purposes, at the rate of sixpence per Board of Trade unit. The current will be alternating, and will make about 3,000 complete alternations, or 6,000 reversals per minute. It will be supplied at a pressure of 100 volts for incandescent lamps, and may be employed at the same pressure with a choking coil in circuit for alternating-current arc lamps arranged two in series. By special arrangement very large consumers can be supplied at any other pressure within the limits permitted by the Board of Trade. A Board of Trade unit being equivalent to the energy transmitted by a current of 1,000 amperes flowing for one hour under a pressure, or E.M.F., of one volt, corresponds to 1,000 watts for one hour, or rather more than 1⅓ h.p. for one hour. An 8-c.p. lamp takes a little more than 30 watts, and will, therefore, points out the committee, cost about one-fifth of a penny per hour for current. Large incandescent lamps of 100 c.p. and upwards are made with much higher efficiency—viz., about two watts per candle—so that 100 c.p. can be obtained for 1½d. per hour. After the present year, the cost of incandescent lamps will be greatly reduced, and it will then be economical to use small lamps with an efficiency nearly equal to that of the high candle-power lamps just mentioned. An arc lamp of 2,000 c.p. (nominal) absorbs about 500 watts, and will therefore cost about 3d per hour for current. Besides this it will cost ¼d. an hour for carbon. An incandescent lamp absorbing 60 watts, and giving a light of about 16 candles, will produce sufficient heat to raise the temperature of a little under 1oz. of water through 1deg. F. in one second. An ordinary gas-burner, burning 6ft. of gas per hour, will raise the temperature of rather more than 1lb. of water through 1deg. F. in a second; so that 17 or 18 incandescent lamps of 16 c.p. will be required to produce as much heat as one medium-sized gas flame. Though the heat produced in electric lighting is so small in comparison with that accompanying gas lighting, yet there are purposes for which the electric current may be employed in generating heat. Examples are to be found in electrical welding and in electric furnaces for the fusion of very refractory metals, but other cases may be found in everyday life. To raise the temperature of half a pint of water from that of the town supply to the boiling point requires rather less than 30 watt-hours—that is, rather less than three-hundredths of a Board of Trade unit of energy. With a suitably constructed heater little heat will be lost by radiation, but allowing 33 per cent. for this and for heat absorbed by the vessel itself, the amount of energy required is 40 watt-hours, or one twenty-fifth of a unit, costing ¼d. Tea or coffee might be prepared at this cost in the early morning, while soup, or food for invalids, could be warmed to a suitable heat with the expenditure of very much less energy. A chop or small steak can be cooked in 10 minutes by a current of six amperes at 100 volts, corresponding to 100 watt-hours, or one-tenth of a unit, and costing ⅗d. This can be done on an office table without any unpleasant odour, without contaminating the air with the fumes of partly-consumed gas, and without injury to the table on which the heater is placed. The current may also be employed for supplying small self-starting motors, which are well adapted for driving ventilating fans, or for other purposes requiring small amounts of power. Where large amounts of power are required, special arrangements should be made with the Corporation for the supply of synchronising motors. By the employment of suitably wound induction coils on the ordinary service leads, very beautiful effects in coloured light can be obtained in vacuum tubes of almost any form. These will lend themselves very readily to advertising purposes in shop windows in the evenings after the ordinary lights have been extinguished. The committee maintain that by the adoption of the electric light there is no damage to goods and furniture from any destructive vapours generated by the light, and although the apparent cost of the light may appear more expensive than other artificial lights, yet, taking into consideration the saving effected by the non-destruction of ceilings, wall paper, furniture, etc., and in the case of shops, stock, etc., the actual cost will be found to compare favourably with that of any other illuminant.

Partick.—The Select Committee of the House of Commons of which Mr. A. de Tatton Egerton is chairman dealt on the 17th inst. with the Bill to confirm the provisional order made by the Board of Trade under the Electric Lighting Acts, 1882 to 1890, with reference to the burgh of Partick. The general purpose of the order is to empower the Commissioners of Partick to provide electric light for private or public purposes by means of a scheme approved by the Board of Trade. Mr. Meysey Thompson appeared for the Partick Commissioners, and Mr. Pope, Q.C., and Mr. Balfour Browne, Q.C., for the Corporation of Glasgow, who were the only opponents of the Bill. Mr. Meysey Thompson, in opening the case, explained that the order had been determined upon in the autumn of last year. Any person affected by it had a right to take objection before application was made to the Board of Trade; but the Corporation of Glasgow had allowed the early stages of the proceedings to pass without taking the slightest action. It was only after the first reading of the Bill in Parliament that any indication was given of their dissatisfaction with the proposals of the Commissioners. He protested against this method of procedure on the part of the Corporation, more particularly as the Bill was framed on the model clauses now in operation in hundreds of cases throughout the country. He submitted that in their petition the Corporation gave no sufficient reason why the clauses of the Bill thus framed should be modified. He understood they were satisfied with the provisions so far as they might affect them as Gas and Water Commissioners, and that the only matter requiring attention was the question of the tramways. Their petition alleged that the Commissioners of Partick, who were the road authority within the burgh, might "break up the tramways and the streets in the area of supply, and along which the trams are laid, and interrupt the traffic thereon, and so cause loss to the petitioners, for which no adequate compensation is provided." At the present moment the Corporation of Glasgow had no more than company powers as regards the trams, but they claimed to have the power to work the tramways themselves, and the present lease expired in July next. He would say that the promoters were quite ready to amend the Bill so as to provide that due notice should be given the Corporation of any work which they proposed to do in the streets in which there were tramways. Mr. Pope asked if the promoters conceded this without conditions, because if it was to be taken as a full discharge of the claims of the Corporation it could not be considered satisfactory. Mr. Meysey Thompson said the promoters were quite willing to amend the Bill in the way he had indicated, but any question of compensation would be a matter for arbitration, for which the Bill already contained a provision. He thought that power of reference to arbitration and notice of interference with works constituted a sufficient protection of the tramway property. Mr. Balfour Browne submitted that what was offered was not sufficient. The trams in the streets of Partick might be worked by the Corporation in July, 1894, and up to that time they knew nothing of what the promoters proposed to do. So far as the notice was concerned, they were satisfied; but what they wished to secure was that any arbiter called in should not determine where the wires to be laid down were to go independent of the provisions of the Corporation's Act of 1891. If the Corporation made a cable tram, as they proposed to do, and as they had full right to do under the Act of 1891, they would need to go to a depth of 3ft. below the surface of the street. The arbiter might allow the Partick people to put the lines exactly where the Corporation's cable was to be, and make the cable impossible. This could be avoided by an instruction to the arbiter to consider the power of the Act of 1891; indeed, it should be imperative on him to do so. He should be told that the promoters were not to lay their wires so as to prevent the Corporation laying down a cable tram. Instead of trusting to the discretion of the arbiter the Corporation preferred to rest on the statutory powers given by the Act of 1891. What he suggested was that there should be inserted in the Bill words providing that the arbiter should determine that all works, in so far as reasonably practicable, should be kept clear of the trams and not laid under them. Mr. Pope pointed out that if once the Burghs Commissioners got the power to lay down their wires there was no power in existence to compel the removal of them. He contended that the Corporation's Act of 1891 gave them absolute right to lay down a cable tramway. Mr. Meysey Thompson said the right was subject to the sanction of the Board of Trade. Mr. Pope demurred to this. The Chairman, after consulting Mr. Bonham Carter, referee, and his colleagues on the committee, said they were of opinion that the sanction of the Board of Trade must be obtained before the Corporation could convert the present horse tramway into a cable tram. Mr. James Donaldson, clerk to the Partick Commissioners, then gave evidence in support of the preamble of the Bill. The Chairman asked for evidence as to the depth under the street required for the proposed cable tramway. Mr. Rankine, C.E., went into the box and explained that 2ft. would be required for the frontage of the culvert and another foot for drainage. The committee then deliberated in private for a time. When counsel and parties were admitted to the room again, the Chairman said the committee are of opinion, after consideration, that by adding certain words both parties should be satisfied. The arbitration clause now reads, "In settling any question under this section the arbitrator shall have regard to any duties or obligations which the owners may be under in respect of such streetway, tramway, or canal," and we propose to add to it these words, "and to the powers under the Glasgow Corporation Act of 1891." Mr. Meysey Thompson said if the committee would add the words "and reservations," he would be satisfied. The Chairman thought that was covered by the word "powers," but the committee had no objection to insert the word "reservations." Mr. Meysey Thompson said he thought the parties were now agreed. What they proposed was that a new sub-section should be added to clause 11, which would read, "For the purpose of this section the expression owner should include the Corporation of Glasgow as owners of the trams in relation to any tramway owned by them in the area of supply." The plan was that the Corporation should receive notice of any proposed work as well as the lessees. In clause 12 it was proposed to insert a provision that the expression "givers" should include the Corporation of Glasgow. This having been agreed to, the committee ordered the Bill to be reported to the House.

Gas-Engines for Yarmouth.—A correspondent, "Electricus," writes to the *Yarmouth Independent*, urging the use of gas-engines for town electric lighting. After pointing out that the cost of production is rapidly being reduced, he alludes to the most economical method extant—that is, generating the current by means of gas-engines, driven by what is known as Dowson or generator gas. "This gas," he says, "can be produced at an abnormally low cost, someting like 1½d. per thousand cubic feet, but as its calorific or heating value is only one-fourth that of town's gas, one has to use four times as much; this, of course, brings the cost up to 6d. per 1,000 cubic feet, which is still low, compared with town's gas at 3s. 4d per thousand cubic feet. With this cheap fuel gas and a first-class gas-engine, the cost of generating the electrical unit comes out at 1·51d., or roughly 1½d. per unit; this includes working expenses, fuel, and 7 per cent. depreciation on plant, and 5 per cent. interest on borrowed capital. These figures are the results of practical working on a large scale, and applies to town-lighting. With an installation of 5,000 lamps at a capital outlay of £10,000, I estimate that two-thirds of the lamps installed would be at work simultaneously; this means an output of about 224,000 units per annum, which at 4d. per unit would equal a revenue of £3,733. The total cost of generating and supplying being 1½d. per unit, the cost per annum on 224,000 units amounts to £1,400. This signifies a profit of £2,333, which is available for the reduction of the rates. These figures are based on the assumption that at least two-thirds of installed lamps are alight at one time. In Great Britain alone there has been sold for electric lighting purposes gas-engines whose aggregate horse-power exceeds 7,000. In Germany also they are used for 1,100 arc lights, and about 90,000 incandescent lamps. The following are the points in favour of gas-engines: 1. When ordinary town's gas is used for driving the engines of an electrical station, the consumption is about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners. 2. When such gas is used, neither boiler nor fireman are required, and there are no ashes to remove; much less space is needed, no accumulators are necessary, except such as may be employed to equalise the load of the engines and to provide for a small amount of storage. The engines can be worked in the most crowded districts, close to where the lights are required, and no boilers are allowed, thus effecting a considerable saving in copper and trenching. 3. When generator gas is used, the consumption of fuel under full load will be at least 50 per cent. less than with steam power, and the loss due to steam-boilers not being fully worked can be avoided. The consumption of gas per kilowatt at the Dessau station of the German Continental Gas Company was 29 cubic feet, working with accumulators. The average consumption with engines under varying loads, without accumulators, is about 47 cubic feet per kilowatt-hour. With 47 cubic feet per kilowatt, and 55 watts per 16 c.p., one light of this power requires only 2·6 cubic feet of gas per hour, whereas a standard argand burner requires five cubic feet per hour to give the same amount of light—viz., 16 candles. With steam the consumption averages, with accumulators, about 6lb. per kilowatt (4·3lb. per horse-power), and 9lb. to 12lb. when they are not used; thus it will be seen by the above and following figures that a great saving is effected by the adoption of gas power in preference to steam." The cost of plant for proposed installation of 5,000 installed incandescent lamps, with two-thirds of them alight simultaneously—that is to say, about 3,300—is thus given. Power supplied by generator gas and gas-engines:

Buildings	£850
Engines	1,500
Generator gas plant	650
Mains, feeders, including trenching and all labour	4,500
Incidentals	1,000
Working capital	1,500
Total capital outlay	£10,000

Estimated annual cost of working and maintaining the installation:

	£	s.	d.
Fuel consumed per week of seven days	£5	0	7
Chief engineer	2	0	0
Assistant ditto	1	5	0
Two outdoor men	2	0	0
Gasmaker	1	10	0
Depreciation at 7 per cent.	4	2	6
Interest at 5 per cent.	10	7	9
Oil, waste, and petty stores	0	17	6
1·51 of 1d. per Board of Trade unit.	£27	3	4

The cost of plant for proposed installation of 5,000 installed incandescent lamps, with two-thirds of them alight simultaneously—that is to say, about 3,300—is as follows. Power supplied by steam-engines:

Buildings, including shaft	£2,400
Engines and boilers	4,500
Mains and feeders, including trenching and all labour	4,500
Incidentals	1,000
Working capital	2,500
	£14,900

Estimated annual cost of working and maintaining the installation:

	£	s.	d.
Fuel consumed per week of seven days	£12	18	3
One chief engineer and inspector	3	9	0
One assistant ditto or driver	1	12	0
One stoker	1	5	0
Two outdoor men	2	10	0
One trimmer and stoker, etc.	1	0	0
Oil, waste, and petty stores	1	0	0
Depreciation	9	6	0
Interest	14	6	6
Water		1	9
2·65 of a 1d. per Board of Trade unit.	£47	8	6

PROVISIONAL PATENTS, 1893.

MAY 15.

9662. **An electric lamp for bicycles, tricycles, vehicles, and all kinds of rolling-stock.** John Edward Baily Walker, 104, Colmore-row, Birmingham.

9664. **Improved plug for combination electric candle fitting.** Ch. Mellier and Co. (Godfrey Dinlacher, and B. A. Lacoste), 48, Margaret-street, Cavendish-square, London.

9670. **An electro-chemical purifying process in ironmaking, and for other purposes.** Samuel Dickinson Williams, William John Clapp, and George Henry Llewellyn, Moorlinch House, Clytha Park, Newport, Mon.

9699. **Improvements in connection with connecting joints for electric mains, telegraph wires, and telephones.** William Gordon, 17, Jeffrey-street, Camden Town, London.

9716. **An improved method and apparatus for the production of electrical effects in ballets and other theatrical representations.** Wolf Defries and Victor Isidore Feeny, 60, Queen Victoria-street, London.

MAY 16.

9753. **Improvements in electrical and other measuring instruments and apparatus.** William Edward Ayrton and Thomas Mather, Central Institution, Exhibition-road, South Kensington, London.

9779. **Circuit switch.** Charles Arthur Allison, 52, Chancery-lane, London. (The Electrical Specialty Company, United States.) (Complete specification.)

9780. **Improved electrical apparatus for obtaining light.** Frederick Ville Wood, 52, Chancery-lane, London. (Complete specification.)

9805. **Improvements in contacts for making and breaking electrical circuits.** Siemens Bros. and Co., Limited, and Frank Jacob, 28, Southampton-buildings, Chancery-lane, London.

9810. **Improvements in or connected with incandescent electric lamps.** Henry Clay Bull, 57, Chancery-lane, London.

9818. **Improvements in underground conduits for electrical conductors.** James Fulton Cummings, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9819. **Improvements in electric circuit controlling devices.** *William* Phillips Hall, 45, Southampton-buildings, *Chancery-lane, London.* (Complete specification.)

9821. **Improvements in galvanometers.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Whitney Electrical Instrument Company, United States.) (Complete specification.)

MAY 17.

9864. **Improvements in electrical switches.** Richard George Evered and Alfred Watson, 7, Staple-inn, London.

9906. **Improvements in the manufacture of elements or electrodes for voltaic batteries and electrolytic decomposition cells.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

MAY 18.

9965. **Improvements in or connected with the working and welding of metals by electricity.** Alfred Longsdon, 33, Chancery-lane, London. (The Firm of Fried. Krupp, Germany.) (Complete specification.)

9997. **Improved method of generating electricity direct from heat.** Samuel Coxeter and Henry Nehmer, 4, Grafton-street, Gower-street, London.

MAY 19.

10015. **Improvements in apparatus for use in the utilisation of electrical energy for culinary purposes.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery-lane, London.

10042. **Improvements in and apparatus for the manufacture of plates, grids, or supports for secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

10048. **A current governor for electromotors.** Harry William Buddicom, 28, Southampton-buildings, Chancery-lane, London.

10056. **An improvement in commutators for electric machines.** Camillo Olivetti, 28, Southampton-buildings, Chancery-lane, London.

MAY 20.

10081. **Improvements in and relating to electromotors.** William Greenhalgh, Elmwood Electrical Works, Camp-road, Leeds.

10107. **An improved telephone call.** John Henry Kinsman, 55, Chancery-lane, London.

10129. **Improved electrical conductor.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

10134. **Improvements in the construction of armatures for dynamo-electric machines.** William Brooks Sayers, Henry Alexander Mavor, William Arthur Coulson, and Samuel Mavor, 46, Lincoln's-inn-fields, London.

10142. **Improvements in and relating to electric machines.** Waldemar Fritsche, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

7855. **Electric switches.** Challis.
8222. **Dynamo-electric machines, etc.** Rechniewski.
8745. **Electric switches.** Drake and Gorham.
9450. **Electric bells.** Woodhouse and Rawson United, Limited. (Varley.)
9560. **Electric batteries.** Shrewsbury and Dobell.
10161. **Telegraphic communication with lightships.** Evershed.
10472. **Apparatus for electrical, etc., measurements.** Ewing.
11532. **Storage batteries.** Boese.

1893.

1229. **Secondary batteries.** Lloyd.
1449. **Electrical hose signalling apparatus.** Fowler.
2672. **Electric transmission of power.** Bradley and others.
4818. **Electric switches, etc.** Dorman and Smith.
5709. **Dynamos, magneto machines, etc.** Joel.
6031. **Transmitting electric currents.** Mills. (Courtenay.)
6478. **Dynamo-electric machines, etc.** Thomson.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¾
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6¼
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6½
National Telephone	5	5¼
St. James'	—	8½
Swan United	3½	3½
Westminster Electric	—	5¾

NOTES.

Bristol.—An electrical exhibition is proposed to be held at Bristol to inaugurate the Corporation lighting.

Society of Arts.—The conversazione of the Society of Arts will be held at the Imperial Institute on June 21.

Presentation.—Captain Ronald A. Scott, West London Rifles, was presented at last Monday's levée by Colonel H. Trotter, Grenadier Guards.

Wiring Rules.—A set of regulations, somewhat on the lines of those of Mr. Musgrave Heaphy, of the Phœnix Fire Office, has been drawn up by the Society of German Fire Insurance Companies.

Baltimore.—Electric traction is to be used on the underground railway at Baltimore. Locomotives weighing 90 tons, on 12 wheels, will be used, as the trains are heavy. Overhead trolleys are to be used.

Economic Incandescent Lamps.—What are termed economic incandescent lamps are being made in Vienna. It is said that these lamps at normal powers consume less current, and that notwithstanding their shorter life a saving to the consumer is effected of from ½ kreutzer to ¾ kreutzer per lamp-hour.

Obituary.—The death is announced, at Zurich, of Dr. Hipp, formerly the principal of the firm of Hipp, of Neufchâtel, one of the oldest manufacturing houses of telegraphic and other electrical apparatus. Dr. Hipp, who was 80 years of age, was the inventor of a number of appliances, one being an electric clock which was well known.

Municipalisation.—A point in favour of the municipalisation of the supply of electric light is to be found in the case of Cologne. There, during the half-year ending March 31, 1892, the net profit of working amounted to £3,000, which was, of course, available for assisting in carrying out new municipal undertakings, or in the reduction of rates.

Board of Trade Automatic Signalling.—For the first time in its history, the Board of Trade has sanctioned the use of automatic signals on a railway. This concession has been made in the case of the Overhead Electric Railway in Liverpool, and, though only seven miles long, the company will save from two to three thousand pounds yearly in signalling expenditure.

Death at Service.—The *New York Herald's* correspondent at Chorrillos, in Peru (says the Central News), states that the duplicate cable of the Central South American Company has been completed. Mr. Lumsden, an electrician, and Mr. Armes, foreman, were drowned on the 1st ult. at Salina Cruz while landing the shore end of the cable. Mr. Lumsden was the son of a gentleman engaged in the British Postal Department.

Contract for Underground Mains.—An opportunity will be open till the 1st of July for individuals and firms who make a speciality of supplying material for, and undertaking the installation of, underground mains, pipes, and manholes. The Electric Lighting Committee of the Halifax Corporation, as will be seen from our advertising columns, ask for tenders from persons capable of such work, in connection with the electricity station now in course of building.

Catching Trains.—A curious advantage on the side of electrical railways has been noticed where these run side by side with steam suburban railways, due to the greater speed and lightness of the electric trains. A practically constant service is given of these latter, starting every few minutes: there is no waiting and no need of catching any particular train. The relief of mind on the part of business men in not having to catch their train is felt so strongly as to weigh over the balance towards the electric cars.

Faulty Mains.—The experience gained by the Popp Company in Paris with its electric light mains will prove very valuable to those connected with the undertaking; but as the piper is paid mostly by German capital, the French need not grumble so much. Three times already have the mains been replaced by others, and now for the fourth time new cables are being laid. These are lead-covered armoured cables, which, it is hoped, will help the company to surmount the difficulties met with in distribution.

Lighting of Munich.—In the matter of electrical illumination of streets, Germany is very much behind, even Berlin having little more public electric arc lighting than that of Unter den Linden. In fact, operations everywhere have been mostly confined to the illumination of two or three streets. Munich will, however, be the first town in Germany to have a large system of street electric lighting, which, together with the supply to private consumers, is to be commenced by Messrs. Schuckert and Co., of Nürnberg, in October.

Personal.—Mr. Cawley, who has been chief editor of *Industries* since our contemporary was started some seven years ago, is about to retire, but not before gaining for *Industries* an established position in the field of technical journalism. At the beginning of this year a change occurred in the proprietary of our contemporary, and this, we understand, led to Mr. Cawley tendering his resignation. After concluding his editorial work he intends carrying on business as consulting engineer, and has taken offices at 29, Great George-street, Westminster, S.W.

Traction and Telephony.—Just as we are on the eve of a consideration of, and let us hope satisfactory conclusion, of the traction *versus* telephone problem, we learn that disturbances have occurred in the telephone wires adjacent to the electric tramway now being experimentally tested in Breslau. Similar trouble took place on the inauguration of the Bremen trolley line, but it was soon overcome, as will no doubt be the case at Breslau. Still, with metallic circuits, such as we believe generally prevail in Germany, induced currents in telephone wires should not occur.

Light for Holland Park.—Sir Frederick Leighton, P.R.A., is anxious to have electric light in his magnificent abode, but apparently cannot get it, as he has written to the Kensington Vestry calling attention to the fact that electric lighting mains had not been laid in Holland Park-road by the Notting Hill Electric Light Supply Company, and enquiring whether the Vestry can enforce the supply of electrical energy to his house, No. 2 in the road. If not, he wants to know "whether steps might be taken to rescind the company's order." This is pushing matters with a vengeance. The letter was referred to the Select Committee.

Battersea Polytechnic.—Mr. Sidney H. Wells, Wh.Sc., Assoc.M.Inst.C.E., Assoc.M.Inst.M.E., of the Yorkshire College, Leeds, has been appointed principal of the Battersea Polytechnic Institute. Mr. Wells was formerly assistant-master on the engineering side of Dulwich College, and in addition to a scientific education has had the advantage of a practical training in the works of Messrs. Maudsley's, Westminster. He is a popular and successful lecturer, and his connection with technical education both in London and Leeds will be of great assistance to him in performing the duties of the important position to which he has been appointed.

A New Street Danger.—Under this heading Mr. Tom Bird, of Brook-street, W., writes to the *Times* as follows: "Sir,—May I call attention in your columns to a source of danger in many of our streets, owing to the non-ventilation of the 'boxes' of the electrical companies? In the endeavour to keep these dry some are almost airtight. The result is that last night the composition covering (in an iron frame) of one in Brook-street, opposite the end of South Moulton-street, was blown out of its socket, with apparently great force. These coverings are of some weight; in addition they are somewhat held by the red lead used in filling up the gap between the two frames."

Difference of Phase.—M. Désiré Korda has utilised an interesting property of the electric current to measure directly the difference of phase of two sinusoidal currents of which neither the strength nor periodicity is known. A coil placed in a thin rotating magnetic field, in synchronous rotation therewith, cannot have currents induced in it as long as the diagram of the field remains a circle, and if at the same time the axis of rotation remains perpendicular to the plane of the field. But when one or other of these conditions ceases to be fulfilled, especially when the intensity of the field is represented by an ellipse, a current is set up in the wire having twice the number of periods as the field.

Tramways and Telephones.—In our last issue, in referring to a meeting of the Association of Municipal Corporations held at the Westminster Palace Hotel, it was mentioned that the subject of tramways and telephones was of such importance that it should be again considered on June 1. The meeting for this purpose was held yesterday, under the presidency of Sir Albert Rollit, M.P., and there was a large attendance of representatives from many corporations. After considerable discussion, extending over nearly two hours, a committee was formed to consider the whole question of telephones and tramways, and the evidence to be submitted to the Joint Parliamentary Committee on Tramways and Telephones.

Electric Welding Car.—A special electric welding car has been constructed at Philadelphia for welding street railway rails in position. The car is provided with an electric welding plant, so constructed that current is taken from the trolley wire and transformed into a low-tension current of desired strength. Experiments have been made at Johnstown, and rails of great length have been formed, avoiding the necessity of fishplates and joints, at the same time avoiding the necessity of bonding the track for the return circuit. On the West End Company's track a girder rail, 25in. square section, was welded with 200 horse-power, and the usual rails require less power. The time taken is from four to sixteen minutes for a complete weld. The rails are welded in place by removing the paving and making contact after connection to the terminals of the welding machine.

Ship and Dock Lighting.—A maritime congress is to be held at the Institution of Civil Engineers between July 18 and 22, Lord Brassey being president of the organisation committee. The honorary secretary is Mr. J. Forrest, the secretary of that institution, and to him any communications relating to the congress are to be addressed. Something like 40 papers have already been notified for consideration, the fourth section dealing with the illumination of lighthouses, communication with the shore, and fog signals. Two or three papers on electric lighting of ships and docks, electric power on board and in docks, etc., would doubtless be acceptable and bear good fruit. The congress will be a big thing, as may be judged by the fact that delegates from France, Germany, Austria, Belgium, Denmark, Spain, and Italy will participate, as will also the large shipping companies.

Electric Tramway in Brussels.—Permission has been given by the Belgian Government for the construction in Brussels of an electric tramway, which will pass along the upper boulevard and connect the northern and southern railway stations. The line will be built for the Société des Tramways Bruxellois on the Thomson-Houston system by the Union Elektricitats Gesellschaft, of Berlin. Before the concession was granted, the municipal authorities and State officials thoroughly investigated the system, and the work of constructing the line is to be commenced at once. The line will have a double track, and its length will be 3·1 miles. There is a gradient of 6 per cent. at the botanical gardens, where it takes four horses a long time to haul up the cars now in use.

Electric Motors for Calico Printing.—Probably the manufacturers of Lancashire, Lanarkshire, and the other great centres of calico printing in this country will consider that their appliances have been developed sufficiently through years of experimenting into good practical machines, not easily to be improved upon; but they do not yet appear to have entertained to any great extent the possibility of driving their printing-machines by electric motors, although an admirable specimen of such a combination was to be seen in the Manchester Jubilee Exhibition of 1887, amongst the appliances shown by Messrs. Mather and Platt, of Salford Ironworks, Manchester. At the Dunnell Printing Works, of Pawtucket, Rhode Island, a complete arrangement has, however, been put into force, whereby the usual double-cylinder steam-engine employed to drive each machine is replaced by an electric motor, and so far with great success, the results being in advance of any other method used for actual daily work.

The "Novak" Incandescent Lamp.—Some further details are now to hand with respect to the latest addition to the ranks of incandescent lamps outside the Edison patents, and a brief note upon which appeared a fortnight ago. The inventor, Mr. John Waring, says that in all lamps where a vacuum is not employed, but where instead the bulbs are filled with a gas which does not chemically attack the carbon filaments, yet the "air washing," as he terms it, or the rapid passage of gas molecules over the highly-heated surface of the carbon (due, presumably, to convection currents), will produce rapid disintegration of the filaments; besides which a great amount of energy is carried off in the shape of heat, because of these currents or eddies in the gaseous atmosphere of each bulb. Accordingly, he employs a gas of great specific density, so that the loss of heat from the carbon may be reduced Of course, care is also taken to use a gas which has no injurious chemical effect upon the carbon. Mr. Waring finds the best results to be obtained from a gas consisting of the vapour of bromine or iodine, or a mixture of both.

Electrical Nomenclature.—In a recent issue we noted the rapid progress made in the United States by the Crocker-Wheeler dynamos and motors, these specialities having attained such a ready sale for ventilation and general power purposes that the company was forced to build fresh works in order to keep up with requirements. The new works are of sufficient size to form a small community in themselves, and being in a district hitherto uninvaded by the builder, they have had to undergo the process of naming. To show that abstract units do not represent the only possible method of glorifying dead scientists, the new centre has been called "Ampere," thereby improving very considerably upon the want of system which ran riot years ago in the naming of American towns, and led to the establishment of Rome, Utica, Troy, Syracuse, and other classical localities hobanob with Indian villages, and all within a few hours' ride of one another. We shall probably have the next world's fair held at "Voltaville"—a city to rank higher than any ordinary New Yorks and Chicagos, and which will be reached by way of "Faraday Junction," "Ohmlands," and "Kelvinside."

Automatic Electric Switch and Signal System.—An automatic electric switch and signal system has recently been introduced at the Philadelphia terminal of the Reading Railroad, which is said to be the largest yet installed. The system will be operated from a single tower, and will control the switches and signals of the terminal from the junction. The switches and signals will be moved by compressed air coming from a power-house, and carried through a system of tubing to the valves of various cylinders working the switches and signals. Connected with these cylinders is a system of electric wires leading from a dynamo, and extending to the tower, where, by the manipulation of small levers, the electric current releases or shuts off the air which works the switches and signals. In the signal-tower are 36 lever machines, each connected with a switch, and 20 signals will be worked. On a long black board facing the leverman is a complete plan of the lines, with models of the switches and signals, which move in response to the levers, simultaneously with the real switches and signals. The signalman is thus kept constantly advised of the exact position of each switch and signal.

Earth Currents.—Mr. J. Kennedy Gibson contributes from Port Darwin, South Australia, an interesting note (with a diagram) to the *Electrical World* of May 20, on earth currents. At intervals during six months he has taken observations on one of the Java-Australian cables. In all, the daily variation presented a close uniformity of outline and a marked agreement of times of maxima and minima. The variation is very different to that on the Atlantic cables, for while the latter presents two complete alternations every 24 hours, Mr. Gibson notices only one complete alternation occupying about 13 hours, and during the remainder of the night the earth current is weak and variable in direction. The slope of variation is sometimes in accordance with tidal lines, but sometimes in opposition or at intermediate positions; and there is no slope of earth-current variation during the night. He is disposed to receive with caution any hypothesis which seeks to find an explanation of the earth-current variation in moon and sun individually, for he thinks the causes are very complex. He thinks it likely, as magnetic disturbances are recognised as being due to solar influences, that the normal earth-current variation is due chiefly to solar influence, to lunar effects in a minor degree, and also that it is affected by thermometric and barometric variations.

Federated Institution of Mining Engineers.—A general meeting of this institution was commenced yesterday at the Institution of Civil Engineers, and will be continued to-day and to-morrow, under the presidency of Mr. George Lewis, who delivered an address. In the course of his remarks, the president stated that he did not consider the manner of holding examinations for colliery manager's certificates was on the whole satisfactory. He therefore suggested the formation of a central board to control certificates of the first class, and that the examinations for those should take place in London. The examiners should be appointed by the board, but the president would alter the present arrangement, in so far as to appoint professors of the various subjects, instead of, as now, mining engineers, who examined upon all subjects. The examiners should consist of professors of mechanical engineering, chemistry, electricity, mining engineering, or a board of mining engineers. To-day members will be received by Prof. A. B. W. Kennedy, at the Davies-street station of the Westminster Electric Supply Corporation, and by Mr. C. O. Grimshaw, at the Eccleston-place station. To-morrow, visits will be paid to the Beckton Gasworks, and the works of Messrs. Maudslay, Sons, and Field, Mr. W. B. Basset receiving the members at the latter works.

Pocket-Books.—How is it that compilers of pocket-books do not compile what is wanted? There is, as yet, no absolutely satisfactory electrical engineer's pocket-book, though several authorities have tried their hands at the production of such a work: these usually containing both too much and not enough, and the information is not always that which is really wanted when it is given. When all is considered, what are the requirements? Is it necessary for the pocket-book to go into the waistcoat, like Prof. Thompson's? Should it really be a pocket-book at all? Should it contain electrical information only, or mechanical engineering as well? All these are questions for the engineers themselves to decide; but as very few electrical engineers, if asked, confess to having found the pocket-book they want, it is evident an ideal book is yet to be made. One well-known electrical engineer gives it as his opinion that if one wants a useful pocket-book one must go to Germany; he swears by Hütte's "Pocket-book of General Engineering," published by the Verein Hütte, which gives succinctly both theory and formulæ on usual engineering matters, with a chapter on electrical subjects. As work goes nowadays, the questions of general engineering—buildings, girders, engines, pulleys, belting, rails, and traction—play quite as important a part in electrical work as purely electrical problems. An electrical engineer's pocket-book should contain formulæ for dealing with these; it should avoid redundant matter; it should not aim to teach, but to remind; and it should contain the formulæ in their most workable form.

Discharge Through Gases.—A paper was read recently before the Royal Society by Prof. J. J. Thomson, F.R.S., on "Electrolysis of Steam," in which the repeated discharge of electricity through gaseous matter, noticed as ribbon flashes in lightning, is thus explained: "When an electric discharge passes through a gas, the properties of the gas in the neighbourhood of the line of discharge are modified. Thus, as Hittorf and Schuster have shown, the gas in the neighbourhood of the discharge is no longer an insulator, but can transmit a current under a very small potential difference. Faraday's remark, that when once a spark has passed through a gas the passage of another following immediately is very much facilitated, is another example of the same thing. We have thus good reasons for believing that when a spark passes through a gas it produces a supply of a modification of the gas, whose conductivity is enormously greater than that of the original gas. I have shown (*Phil. Mag.*, November, 1891) that the conductivity of this modified gas is comparable with that of strong solutions of electrolytes. When the discharge stops, this modified gas goes back to its original condition. If now the discharges through the gas follow each other so rapidly that the modified gas produced by one discharge has not time to turn to its original condition before the next discharge passes, the successive discharges will pass through this modified gas. If, on the other hand, the gas has time to revert to its original condition before the next discharge passes, then the discharges pass through the unmodified gas. We regard this as being accomplished by means of successive decompositions and recombinations of its molecules, analogous to those which, on Grotthos's theory of electrolysis, occur when a current passes through an electrolyte."

Gas Power for Electric Lighting.—The last published volume of *Minutes of Proceedings* of the Institution of Civil Engineers contains the valuable and interesting paper read before the Institution on the 10th January by Mr. J. Emerson Dowson, under the above title. In this paper the author deals more especially with reference to the load factor of electricity supply stations as compared with the consumption of fuel per unit generated, and aims at showing how a great deal of the heavy expenditure in modern supply stations (where steam is used) upon fuel, water, and wages may be reduced, if not altogether obviated, by the employment of gas-engines. Of course, his main object is to advocate the use of engines driven by generator gas, but considerable attention is paid in the paper to the advantages of working engines under certain conditions with ordinary town gas. The discussion included some interesting speeches by Messrs. H. Graham Harris (who considered that the desideratum for a gas-engine to be used for electric lighting was one with at least as regular turning movement for variable loads as could be obtained in a double-acting steam-engine at a fairly low speed, and capable of being easily coupled direct and carried on the same bed-plate as the dynamo); Henry Lea (who thought that the Dowson generating plant was more especially applicable to the intermittent work of an electric lighting supply station on the score of fuel economy); General Webber (on whose authority it was stated that the obstacles to an extensive use of gas-engines in electric lighting work were due very largely to financial reasons, as, for instance, the extremely high prices current until quite recently). Prof. Kennedy thought that the possible saving in the cost of generating electricity had been over-estimated, and it was pretty much a case of "half-a-dozen" and "six" in the matter of steam and gas. Mr. Kapp gave figures to show that in small towns and large private installations his experience had been to show undoubted advantages, and was corroborated to some extent by Prof. Forbes, who considered that in many cases it would be perhaps more economical to use gas for distributing power to sub-stations than to spend money on street feeders. Mr. Thomas Preece also quoted the excellent results obtained at Morecambe, where the town electricity supply station is driven by gas-engines.

Obituary.—With regret we have to announce the death of Mr. A. W. Meston, an ingenious and comparatively young electrical engineer, the inventor of the Meston alternating-current motor, a brief description of which we have recently given. Mr. Meston died at his residence, St. Louis, from consumption after a lingering illness of several months. Our readers will be interested to know that the late Mr. Meston was a Scotchman by birth. Born near Edinburgh some 26 years ago, he went to America when a lad of 14, and some few years back began to study electrical engineering at the Washington University, during which time he made his mark for originality in research. In 1890 he commenced business in St. Louis in combination with his brother, which resulted in the organisation of the Emerson Electric Manufacturing Company, which was founded in 1891 to develop his various inventions. Mr. Meston was a keen student in electrical matters, and his work has been watched with interest in American electrical circles, where his small motors for ventilating fans have become very popular amongst alternating-current men. His special study was that of adapting alternating-current motors for use on single-phase circuits. It may be stated that one of the leading features in the latest type of the Meston slow-speed motors is the regulating device which permits the motor to be reversed at will, and the speed to be varied according to actual requirements of the periodicities of the circuits—a problem which has hitherto baffled many other inventors working to attain this much desired end. Another feature of the Meston motor is that the construction of the armature is wireless, having no wire on it whatever; hence no burn-outs can possibly occur, and this method opens up new ground for the study of the many applications of alternate-current motors. Mr. Meston, like most inventors, had a longing idea to make his work known in his native country, and with that view arrangements were recently made with Messrs. Shippey Bros. to organise agencies throughout Europe for the sale of the Meston motors. Although Mr. Meston has left the world at the early age of 26, his work cannot fail to be recognised in electrical circles, resulting as it has in the construction of one of the first successful small alternating-current motors. The public may receive the benefit of Mr. Meston's work in increased usefulness of the electric current, and the companies in increased dividends. His name is, therefore, worthy of remembrance, and everyone will feel regret for a life untimely cut short.

Surface-Contact Electric Tramways.—A conduit system that has been in successful use on an electric tramway for four months, is deserving of attention from electrical engineers. This system is called the Munsie-Cole system, and the place of use is at Hartford, Connecticut. The principle is not difficult to understand, and is unlike that of other conduit systems hitherto presented. Boxes are placed underground at car-lengths apart, at which electric connection to the main underground conductor can be made. This connection is obtained by means of a long flat bar carried on the car, and just clearing the ordinary street-level. The boxes spoken of finish off above the road-level, with a cast-iron knob projecting upwards a little way, having a small slit in one direction. Into this slit, as the tramcar moves ahead, passes the connecting bar, pressing down a little trolley wheel, which is otherwise kept up by strong springs. This downward movement, caused by the weight of the tram, forces a wedge contact inside the box to enter the jaws of a spring-jack, thus connecting for the moment the trolley wheel, and through it the connecting bar and car motor, to the main conductor underground. There is no sparking at the wheels, as the ribbon bar is long enough to be in circuit with the succeeding box before leaving the first, and there is no sparking at the contacts as the wheel is out of circuit before contact is broken. To prevent the metal ribbon from grounding, it is protected at each end by metal shoes, insulated from the bar, which guide the bar into the slit, and in addition the cover is made of two parts, the inner of which is insulated. A strong claim is made for the system for its high insulation. The conductor main is any well-insulated lead-covered cable, tapped only at the boxes to the spring clips. These are thoroughly insulated from the ground by the best materials. The little wheels, the only part of the system visible to the eye in the boxes, cannot cause leakage, and they are harmless to touch, for as soon as the car passes the springs beneath lift them out of contact. All that is required in the way of excavation is a narrow trench and a hole every 16ft. The cost of laying, exclusive of the cable, is about £1,200 a mile. The system is being introduced by the Munsie-Cole Electric Railway Company, 16 and 18, Exchange-place, New York. It certainly seems an ingeniously thought out system; if the insulation is really, as is stated, excellent, the only possible objection would seem to be the series of little knobs on the roadway. This is not very serious; if otherwise, an efficient system of putting the trolley in the slot is obtained.

University College.—Dr. Fleming's dream for a complete electrical engineering laboratory is at least in good part fulfilled, and a State opening of the new wing at the University College by the Duke of Connaught took place on Monday. Gower-street was gay with bunting, and the duke was received by the president of the college (Mr. Erichsen), the vice-president (Lord Reay), the president of the senate (Mr. Justice Charles), and the chairman of the Buildings Committee (Mr. Douglas Galton). The band of the Scots Guards played before a distinguished gathering. Among those present besides the president, council, and senate were Lord Playfair, Lord and Lady Kelvin, Lord and Lady Thring, Sir Henry Roscoe, M.P., Sir Edward Bradford, Sir James and Lady Crichton Browne, his Highness the Thakore Sahib of Gondal, his Highness the Maharajah of Bhawngar, Sir Blundell Maple, M.P., the Chief Rabbi, Judge and Mrs. Digby, Sir David Salomons, Mr. Justice Wills, Sir Henry Thompson, Prof. Kennedy, Mr. W. H. Preece, and Mr. and Mrs. Siemens. His Royal Highness was conducted into the electrical lecture-room, and thence to a platform erected in the engineering laboratory. The president of the college then made a statement of the circumstances leading to the erection of the new buildings. He said the laboratories had been constructed in order to give better opportunities for research and instruction in engineering and electrical technology than previously existed in the college. The cost of the extension was £20,000, and the council appealed to the liberality of the wealthier inhabitants of the metropolis, and especially to the great City companies, for funds to assist them in defraying an expenditure which had seriously taxed the resources of the college available for such a purpose. The Duke of Connaught then declared the building open, saying that every Englishman "must recognise the very vast improvement in thoroughly working out the sciences in which we have pre-eminently shone. Foreign countries are competing with us on all sides, and it is necessary, if we should wish to keep the proud position that we have hitherto held, that we should not be behind them. We must remember it was in this college that the first laboratories existed. But since their establishment other cities and other parts of the empire have gone ahead, chiefly because they have had rich merchants and others who have come readily forward to endow their laboratories." The new laboratories form part of a new wing tending to make the buildings into a quadrangle. The roof is made movable, and will be lifted when the three storeys are complete. The new laboratories cost about £14,000. An excellent mechanical laboratory is erected, and adjacent a dynamo-room and electrical engineering laboratory, with gas-engine, dynamos, and fittings, also lecture theatre and experiment-room. The whole college is shortly to be lighted from St. Pancras central station. The laboratory starts work in October.

Practical Magnetic Units.—While the discussion of the practical magnetic units is one of the principal subjects proposed at the ensuing congress, Mr. A. E. Kennelly's article in the *Electrical World* on the subject will be worthy of attention. Mr. Kennelly first gives a brief review of the history of our units. Up to 1850 all electrical and magnetic measurements, excluding perhaps those of Gauss, were only relative and based on arbitrary standards. But in 1851 Weber pointed out that as electrified bodies, as also currents and magnets, attracted or repelled with forces capable of measurement in dynamical units, these could be expressed in terms of mechanical force—in terms of length, mass, and time. If the forces were electrostatic the expressions obtained for current, resistance, pressure, were called "electrostatic absolute units"; while if the measurements were electromagnetic and obtained from the galvanic circuit, the derived units were called "electromagnetic absolute units." The electrostatic and electromagnetic units for current or resistance, instead of coinciding each to each, as they should do, were found to differ by definite ratios, indicating errors in reasoning which must be left to future discovery to correct. The British Association in 1861 adopted Weber's proposition for absolute units, but selected the centimetre as standard of length. The unit force in the C.G.S. system, a dyne, is approximately equal to the weight of one milligramme of matter. One dyne through one centimetre is one "erg"; and unit E.M.F. sending unit current through unit resistance must expend one erg per second. The resultant standard "ohm" was one thousand million times this resistance—the nearest round figure to Siemens's arbitrary unit — one metre of barometer mercury. The practicable volt is also one hundred million times greater than the C.G.S. unit of E.M.F. We could therefore say, retaining the unit of time, that the unit of length of our present units is a thousand million centimetres — a quadrant arc of the theoretical earth's surface: and the unit of mass that exceedingly minute quantity 10^{-11} gramme. In other words, the practical units would have been arrived at on Weber's electromagnetic system if the length had been an earth quadrant, the mass one eleventh-et gramme. The practical series may therefore be said to belong to the quadrant, eleventh-et gramme and second system, or the Q.E.S. system. However admirable the dynamical relation appeared at first, latent defects show it might be modified with advantage, using, instead of unit pole, the more practical unit magnetic flux, and in electricity unit electric flux, thus relegating 4π to its proper place in spherical problems only. The change would involve all units. Those who would benefit would be the calculators, but all non-calculators would be disarranged temporarily, and have to learn new values: and this difficulty has hitherto prevented the rationalising of the units. The present difficulty in discussing magnetic circuits is the absence of names for the units involved. The difficulty would be in great measure removed if the C.G.S. units had names, even though the transition to the Q.E.S. ohm, volt, and ampere might be at times perplexing. Simplicity requires the unit of flux to be one hundred million of C.G.S. lines—a volt being generated when the flux it encloses changes by units per second. Of the four practical magnetic units proposed by the American Institute of Electrical Engineers—gilbert, weber, oersted, and gauss—the first three are Q.E.S. units, linked with volts and amperes. The gauss is a hybrid, neither Q.E.S. nor C.G.S. Logically, the magnitude of the gauss should be that prescribed by the Q.E.S. series, but this selection is confronted by a dual difficulty. Its Q.E.S. magnitude would be one weber per square quadrant, and not, as proposed, one weber per square centimetre. In the first place, the sectional areas of dynamos are measured in square centimetres, and not in square quadrants, so that the tendency to express flux density in webers per square centimetre is almost irresistible. Secondly, one weber per square quadrant is 10^{-10} C.G.S. lines per square centimetre; and strong dynamo fields would have to be raised through 14 decimal places to be expressed in this unit, and the prefix mega only raises through six. Under these circumstances the Q.E.S. magnitude for the gauss is hard to sustain, but any means that could conveniently reconcile it with the Q.E.S. system would effect a consummation devoutly to be wished.

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 527.)

The other point to be considered in the transformer just designed is the cooling surface per watt wasted at no load and also at full load. This should give an approximate idea of the temperature which the transformer will attain when left on the circuit. The investigation is, however, by no means so simple as might be expected at first sight. Suppose, for instance, we calculate the total cooling surface. The surface of the copper coils and insulation may be taken as that of a cylinder 9¼in. diameter and 15in. long, and thus = π 9¼in. × 15in. = 438 square inches. The end flanges may help to cool the coils, and hence the surface of these should be added = 36 square inches. The iron in the yokes will add considerably to the above. The exposed surface of the iron is about 780 square inches, so that the total cooling surface will be 1,254 square inches. The watts wasted at no load are 144·8, and at full load the total loss rises to 264·8 watts. Working with these figures and the cooling surface given above, the loss comes out at

·115 watt per square inch at no load, and
·211 „ „ „ „ at full load.

These figures appear ample, if viewed in the light of dynamo-magnet practice, but it must be remembered that dynamos have moving parts which create currents of air round the field magnets, tending to make the cooling surface more effective, whereas the transformer not only is motionless, but is boxed up in an iron case which prevents a free circulation of air. Thus the heat has to be transferred from the transformer to the air in the case, again from this air to the case, and finally from the case to the air outside. This is not absolutely correct, as the transformer loses heat by conduction where the yokes rest on the iron box, but still, roughly, we may expect at least two and a half times the rise of temperature that would be found on a field magnet having the same loss per square inch cooling surface. Much, of course, depends on the shape of the transformer, and individual constants should be obtained from practice for the heating formula for each type.

Now, in the above calculation, we have worked with the total cooling surface and the total loss. Even if the loss were uniform through the mass this would give widely different internal temperatures according to the depth of material. It is, however, this internal temperature that causes faults in transformers by heating the insulation on the wires up to a point at which it either chars or becomes rotten. In the transformer designed above the most dangerous point would be the bottom of the coil wound in the centre of the transformer. The heat generated in the iron immediately under this would pass, to a considerable extent, up through the copper, and this heat has to be dissipated by the surface of the copper as well as the copper watts. Considering a vertical section 1in. long, the iron loss in the part of the core thus cut off would be 3·1 watts, and the copper loss in the wire would be about seven watts, giving a total loss in the section of 10·1 watts. Now, the external cooling surface is only $\pi \times$ 9¼in. = 29 square inches, so that the watts per square inch cooling surface in this central section rises to 0·35 at full load, whereas the mean obtained above was only ·211. This is under the assumption that the whole of the heat generated in the section is transmitted radially to the surface, which is not absolutely correct; but if the coil is in the middle of the winding it is not likely to give off much heat to the adjacent coils, which will be at much the same temperature.

In comparing the figures relating to the cooling of transformers the hottest point of the copper circuits should always be considered, and not the mean external temperature only. The highest temperature in the iron does not affect us much, as no ill effects occur from this cause unless the hottest part of the iron is close to the copper, which is seldom the case. The yokes in this design have the largest amount of surface per watt wasted, and hence keep cooler than the centre core. Some makers have reduced the section of the yokes for this reason, as weight can be saved by so doing and the temperature still kept normal. This, of course, causes a higher induction in the yoke, and as the curve of iron loss rises rapidly with the induction, the watts per pound will increase more rapidly than the weight diminishes. Hence the total iron loss is increased by making the yokes of smaller section. Again, working in the inverse direction, some makers have put more sections of iron in their yokes than in the core. This certainly lowers the iron loss slightly, but, as will be found by actual trial, the effect is not very marked, and, perhaps, is hardly worth the increase in labour and material charges.

The methods of constructing the iron cores for transformers of proportions similar to those used in the above diagrams are very numerous. Almost every maker has a different way, and the advantages and disadvantages of the various methods are mainly those of cost and convenience of manufacture. In England the plates are usually arranged so as to interleave one with the other, so that each successive plate added covers up the joint in the preceding layer. There are a large number of different ways of doing this with the present type. Fig. 9 shows one method, and the reader will have no difficulty in devising many others. In this way the magnetic resistance is practically reduced to that offered by the iron, and the air resistance is negligible.[*] So in the curve of permeability, Fig. 5, the necessary data was obtained from a transformer with this system of core plates, and the effect of the small air resistance is thrown into the magnetic resistance of the iron. In some cases, however, the different parts of the iron circuits are fitted together at faced joints, and then the air resistance of these joints will make a considerable addition to the current marked i_μ, Fig. 3. The same formulæ as used for determining the i_μ required by the iron (2) can be used for finding out the increase of current due to the air-gap, which may be called $i_{\mu a}$—viz., $i_{\mu a} = \dfrac{\mathfrak{B}\, l}{\mu\, \tau_2\, 1{\cdot}76}$.

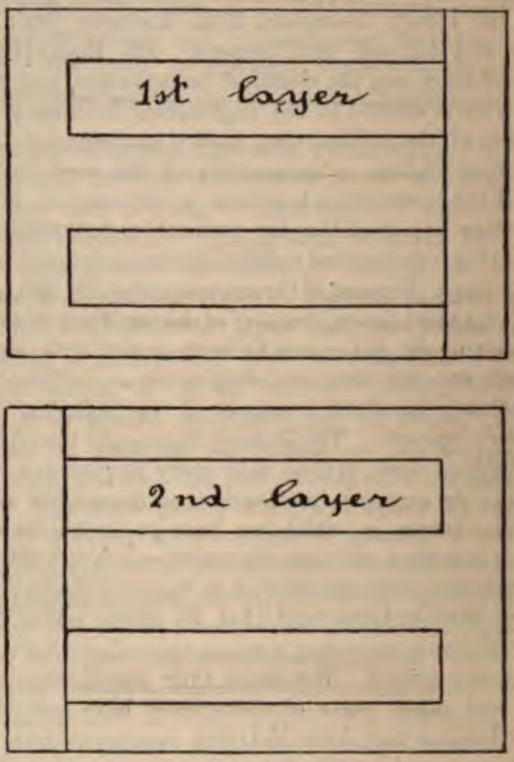


FIG. 9.

In this case $\mathfrak{B}$ = the induction in the air-joint.
l = the length of the air-gap.
the μ for air = 1.

The transformers made at the Oerlikon Works, in Switzer-

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[*] This will be readily seen when looking at the case worked out later for an air-gap having an induction of 3,000 in it. By the interleaving method this induction can easily be reduced to one line per square centimetre, which would reduce the current required for the gap to a figure negligible as compared with that required by the iron—*i.e.*, ·000191 ampere, as compared with ·0858 ampere for the iron. In addition to this, the total gap is much less in the interleaved type, which again reduces the effect.

Speed and Cost.—The speed at which a dynamo runs has a good deal to do with its price, and within certain limits—say, 20 per cent. above the normal and 20 per cent. below—the price may be put down roughly as indirectly proportional to the speed; for example, several dynamos, all having the same output, and of the same design and type, will be built for different speeds, and putting 1,000 revolutions as the average number of revolutions per minute for what are termed high-speed machines, we should have others running at 800, 900, 1,100, 1,200. Putting down the machine at 1,000 revolutions at £100, if we wanted one of similar output and type to run at 900 the probable price would be £100 × 1,000 ÷ 900 = £111—the lower the speed the greater the price; whilst one running at 1,100 revolutions would probably cost £100 × 1,000 ÷ 1,100 = £90, so that the higher the speed, the lower the price. The reason of this is very evident, for by lowering the speed it is necessary to increase the dimensions of the machine, and hence the price. Any increase beyond 1,200 is confined to very small machines. Passing on to what may be classed as low-speed machines, the average is about 400 revolutions per minute. The aforesaid limits may be put down as generally somewhere near to 300 and 500, and the same relation between speed and price holds true here. High-speed machines are driven by belts, a large driving wheel on the engine being used. Assuming a dynamo pulley, or "driven pulley," of 1ft. diameter, has a speed of 1,000 revolutions per minute, it would require a "driving pulley" on the engine, of 5ft. diameter, when the engine has a speed of 200 revolutions per minute; and by employing intermediate shafting dynamo high speeds can be produced from very slow ones of the engine. Low-speed dynamos are used when the dynamo shaft is coupled direct to the engine driving shaft.

As a rule, the larger the output of a machine the lower is its speed; while very small dynamos are run at extremely high speed, say 1,200 to 1,500 revolutions per minute, very large machines do not run much beyond 300 or 400 revolutions per minute when direct driven, and 600 or 800 when belt driven. The true way to compare speeds of machines is to take the "surface velocity." For example, two dynamos may be running at the same number of revolutions per minute, but one may have the armature of larger diameter than the other armature, so that the larger armature is really running at a higher speed, because its surface velocity is greater. The surface velocity is obtained by multiplying the circumference of the armature in feet by number of revolutions made per minute. This is expressed by the formula

$$s = \pi d n,$$

where s = surface velocity in feet per minute, d = diameter of armature in feet, n = number of revolutions per minute, and $\pi = 3{\cdot}1416$. A Siemens machine of 46 units has an armature of 1·33ft. diameter, and runs at a speed of 460 revolutions per minute. In this example we have $s = 3{\cdot}1416 \times 1{\cdot}133 \times 460 = 1{,}921{\cdot}8$ft. per minute; this is for low-speed machines. As a rule, from 2,000ft. to 3,000ft. per minute are the working limits, although 5,000ft. is obtained with small high-speed dynamos.

Output and Cost.—The cost of machines is fairly proportional to their output, when the output does not fall below certain limits; like other kinds of machinery, the cost of dynamos per unit rapidly increases as they become smaller. Fig. 24 gives several curves showing how the price increases as the output increases—the curves are plotted from figures relating to different well-known dynamos. Owing to the irregularity of the curves, it was found impossible to draw curves of any pronounced character, hence they have been drawn from point to point. It is interesting to see how they cross and recross one another, one machine being cheap at one output, but dear at another, etc.

The curve drawn at the right-hand side in Fig. 24 represents the average cost of all the dynamos for various outputs; it is drawn on a scale of one-half that of the separate curves. The values of this averaged curve are seen to map out a distinct path of a parabolic character. Analysing it, we note that a very small dynamo, say, of one unit output, probably the smallest kind made (except toys) would cost £24, and would be capable of running about 15 lamps of 16 c.p., or a couple of arcs of 1,000 c.p.; taking a larger machine, one of five units, the cost comes out about £70, or £14 per unit, whilst a machine of 24 units would probably cost not more than £150, or £6. 4s. per unit. Beyond this point the decrease of cost per unit is very slight, if anything; and the curve will probably travel in nearly a straight line from 24 units. All the dynamos whose curves are given have a speed close on 1,000 revolutions per minute for all outputs, thus enabling a better comparison to be made, and the following are details of the machines—the number of the machine referring to the curve:

No. I. dynamo.—Ring armature, two-pole double magnetic circuit.

No. II. dynamo.—Drum armature, single magnetic circuit.

No. III. dynamo.—Ring armature, two-pole, double magnetic circuit.

No. IV. dynamo.—Ring armature, single magnetic circuit.

No. V. dynamo.—Drum armature, single magnetic circuit.

These five machines have been selected from five districts in England: No. I. representing the Lancashire, or North-West; No. II. the Midland; No. III. the London; No. IV. the North; and No. V. the South-West.

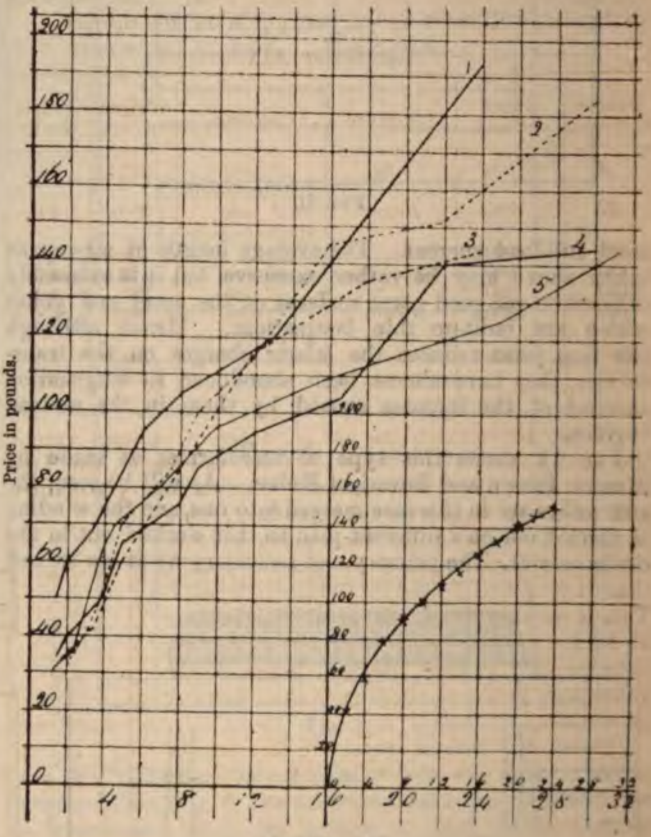

Fig. 24.

With regard to slow-speed machines of 400 revolutions per minute, the cost would be higher than what it would be for a high-speed machine of similar output, because the slow-speed machine must be of greater dimensions and weight. A 24-unit machine would probably cost not far off £300—this is at the rate of £12. 10s. per unit; and one of 50 units about £500, or £10 per unit. It is thus seen that a machine of 400 revolutions per minute costs twice as much as a machine running at 1,000 revolutions, or two and a half times the speed.

Alternators are mostly built for heavy outputs, because they are used for distributing light over wide areas. A slow-speed alternator, running at, say, 400 revolutions per minute, and capable of developing up to 200 units, would involve an outlay of about £1,400, including the "exciter"; this is at the rate of £7 per unit. This machine would run alone 3,000 incandescent lamps of 16 c.p. each, thus costing a little over 9s. per lamp.

Output and Weight.—The weight of dynamos with respect to their output varies for different types and makes, because there are so many details of construction to be taken into account, such as speed of the machine, whether the magnets are made of wrought iron, mild steel, or cast iron, the density of magnetisation employed in the iron, the compactness of the machine, the bed-plate, position of centre of gravity, the current density, limiting temperatures of coils, and general features of design, such as ring or drum armature, single or double magnetic circuits, bi-polar, or multipolar. In addition, machines are built with modifications for certain conditions of working. From this it may be gathered that it is not wise to assume a machine is very efficient or superior to others because it can develop more watts per pound deadweight than other machines can—the word "efficiency" being here employed to signify the life or lasting powers of the machine, the smooth running, absence of repairs, and all things that pertain to true economy. It may be put down, however, that each pound of weight will yield from five to eight watts of electrical power. Criticising machines of various outputs, the weight appears to be fairly proportional to the output—about six watts per pound is a good average; but, as just now explained, one make may give a higher and another a lower value, so that this estimate simply gives a rough idea. The following particulars will serve as the best guide on this subject.

TABULATION XIX.

Output in units.	Speed per min.	Armature.	Magnets.	Weight in cwt.	Watts per lb.
8	1,100	ring	2 pole double circuit	10·75	6·6
22	940	drum	2 pole single circuit	30·0	6·0
50	500	,,	,,	78	5·7
120	600	alternator	10 pole	123	8·7
150	350	,,	12 pole	261	5·1
180	350	drum	2 pole single circuit	265	6·0
200	500	,,	,,	340	5·2
900	—	alternator	—	1,330	6·0

All the above machines are by different makers except the second and third, which are by the same; the fifth is an alternating-current machine, with stationary armature and revolving magnets; the seventh machine is used as a generator for electric railway work, and therefore is more massively built than it would be if used for lighting purposes. This is on account of the great fluctuations of load to which generators are subjected, thus producing great strains; hence, power generators give a smaller figure than lighting generators.

Output and Floor Space.—With similar pattern of dynamos running at about the same speed, the floor space occupied in some cases increases pretty well in proportion to the output, but this relation is liable to be altered from numerous causes. From two to three units per square foot may be taken as an average estimate for dynamos above a certain size running about 1,000 revolutions per minutes, some builders giving higher figures, while others give lower. A few statistics will, however, show best as when considering output and weight. Working out figures for direct-driven machines, it will be found that for heavy outputs the output per square foot is high; as an example, a dynamo running at 375 revolutions per minute gave an output of 126 units, with a floor space of only 28 square feet, this being 4½ units per square foot. Another direct-driven dynamo of 46 units, running at 460, required 13½ square feet, and so gave 3·4 units per square foot. Concerning alternators, four machines of one type, ranging from 30 to 100 units, gave 1·4 to 1·5 units per square foot, the speeds being from 600 to 400; whilst the fifth, of 150 units, gave two units per square foot, the speed being 350.

Probably the most interesting matter, however, will be regarding the space occupied by "combined plants." This term signifies where the steam-engine drives the dynamo direct, the two shafts being coupled up together, and both machines being on one long bed-plate. This arrangement is sometimes named a "steam dynamo." Willans central-valve high-speed engines stand in the front rank, and occupy a remarkably small floor space, probably smaller than any other make. Coupled up to one of Siemens's dynamos, the over-all dimensions of one plant were 9½ft. by 4ft., or a floor space of 38 square feet. The output of the dynamo being 46 units, this comes out to 1·2 units per square foot, the speed being 460 revolutions per minute, the engine alone occupying a space of 5ft. by 3⅓ft. Another plant, with same type and size engine, but one of Elwell-Parker's dynamos, gave when measured a total of 10½ft. by 3⅓ft., or 35 square feet, the output being 44 units. This is 1·26 units per square foot, but here the speed is higher, being 485 revolutions per minute.

A larger-sized plant, a fine type for central-station work where ground is very valuable and floor space limited, measures 15½ft. by 4¾ft., or 73·6 square feet, the output of the dynamo being 126 units at a speed of 375, thus yielding 1·72 units per square foot.

The above will serve as good examples as to how floor space is related to output; in ship work this is a matter of paramount importance, and the same when machinery has to be fixed in the heart of a large and crowded city.

BESSBROOK AND NEWRY ELECTRIC TRAMWAY.

Amidst all the attention and interest excited by the increasing progress made in the development of electric railways and tramways during the past year or two, it is not by any means inappropriate to recall to some extent what has already been done in this direction, if only for the purpose of bringing before the notice of engineers and promoters—now busily engaged on the proposed new lines—some of the essential features that have contributed to the success in erection and daily operation of the few old-established electric lines in this country.

Of these latter, not by any means the least successful has been the Bessbrook tramway, erected and equipped by Messrs. Mather and Platt some nine years ago, under the superintendence of Dr. E. Hopkinson, to whose engineering ability is due a large part of the success achieved, both in design and construction. This line—operated entirely by electric power—traverses a distance of three miles between the town of Newry, in the North of Ireland, and the important manufacturing village of Bessbrook, where large flax-dressing mills are situated close to a convenient water supply, available in considerable quantities for washing and power purposes. The Bessbrook and Newry line deserves, indeed, in many respects, to be entitled a "railroad." Not only is it to a large extent enclosed, and

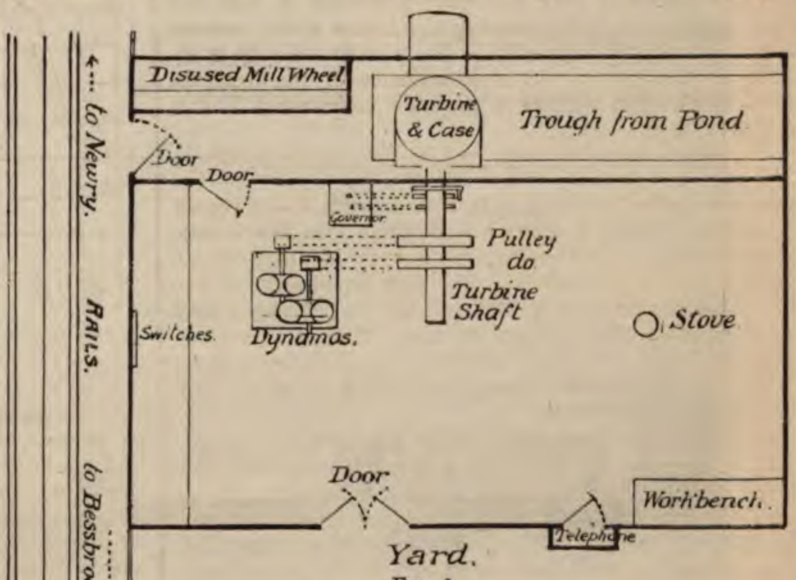

FIG. 1.

carried across country upon land specially obtained for the purpose, as opposed to a mere street or road line, but it also serves to convey no inconsiderable amount of goods traffic in addition to passengers. Indeed, it may be doubted whether a line solely intended for passenger traffic would in such a place have offered any return whatever on the cost of construction, and the wisdom, therefore, of arranging to carry goods also is undeniable.

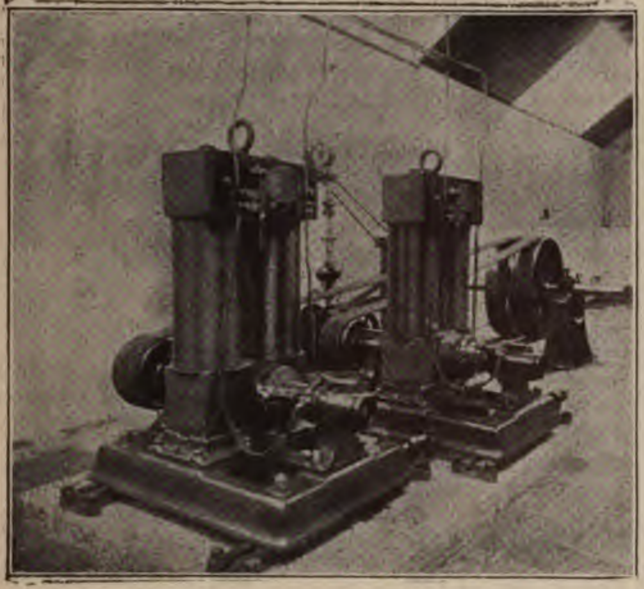

FIG. 2.

An excellent description of this line—after its completion, and when being daily operated with the same success that now obtains—was given by Dr. Edward Hopkinson, the responsible engineer, in a paper read before the Institution of Civil Engineers on December 6, 1887, and published in full in the issue of the *Electrical Engineer* for April 13, 1888. A number of details, however, were of necessity omitted from this account of the line; and in order to complete the record by supplying the deficiencies, whilst at the same time pointing out how much has already been accomplished in electric traction when opportunities are available, the following particulars, with the accompanying illustrations, will have some considerable interest.

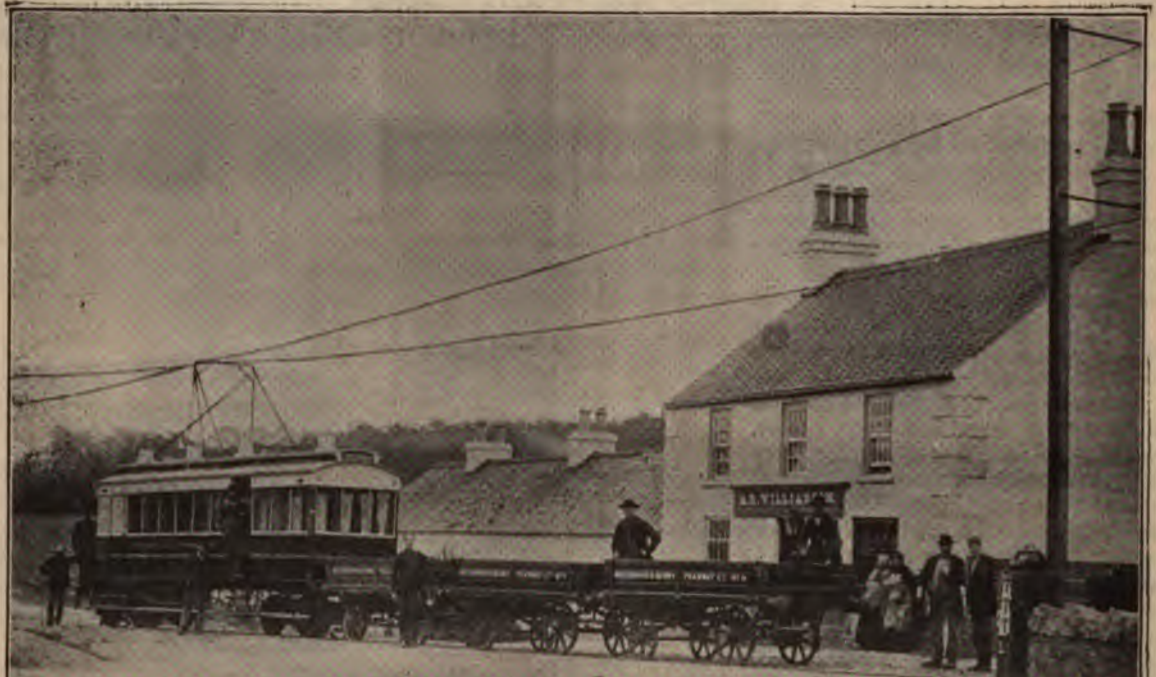

FIG. 5.

There is, of course, no need to give all the details and figures that have already appeared respecting the line: the features explained by Dr. Hopkinson in his paper, and illustrated with diagrams, included the gradients and distances of the line, shown in profile; the terminal stations at Bessbrook and Newry, with the curves or loops by which complicated switching arrangements were avoided; the motor cars equipped to carry passengers and draw one or more of the goods waggons; the system of flangeless wheels adopted on the latter, and the arrangement of inside check or guard rails on the line itself, with the electric conductor of steel channelling placed centrally upon a longitudinal strip of wood which acts as an insulator, and connected at the joints by special copper bond wires. A number of other details have also been published from time to time, showing the arrangements of the power-house, and these may be supplemented by the accompanying plan (see Fig. 1), which represents, though not exactly to scale, the manner in which the old mill race has been used to feed the turbine erected for the purpose of driving the two generator dynamos. This power-house is situated alongside the rails of the line at Mill Vale, almost midway between the two terminals, an old mill being taken for the purpose.

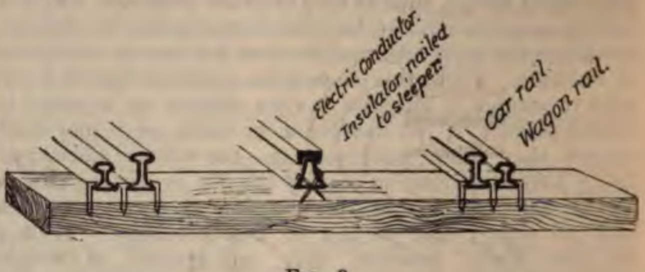

FIG. 3.

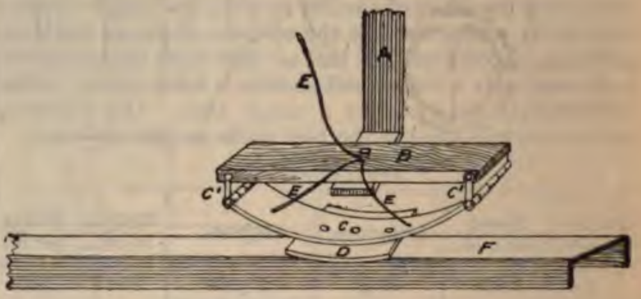

FIG. 4.

Fig. 2 shows in perspective an interior view of the power-house, with the turbine countershaft carried through the wall, and driving the two generator dynamos by link leather belting from separate pulleys. The governor arrangement for regulating the speed of turbine may be seen at the back of the dynamos; as explained by Dr. Hopkinson, the centrifugal balls do not act directly upon the water admission, but throw into action one or other of two bevel wheels, which actuate a small countershaft geared with the valve spindle.

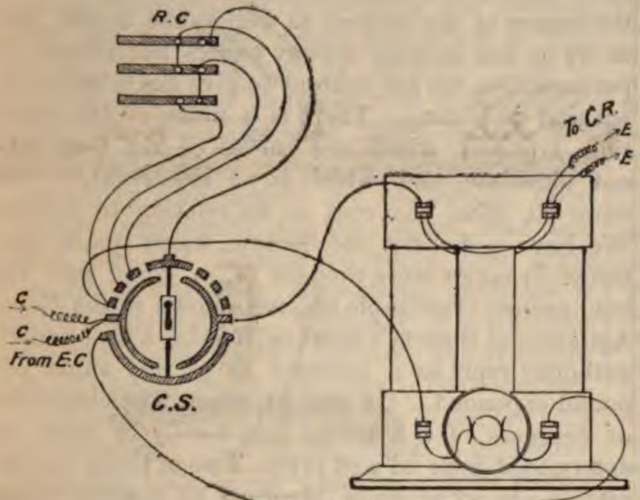

Fig. 6.

In Fig. 3 is shown the system of double rails adopted on this line; the inner one—being raised slightly—serves to carry the flanged wheels of the motor cars, the difference in the height of inner and outer rail being sufficient to allow the flanges to clear the lower rail at points and junctions. Upon the outer or lower rails run the flangeless wheels of the goods waggons, these being kept on the line by the inner rails which act as checks or guards. Both sets of rails are simply fastened down to the sleepers by dog spikes.

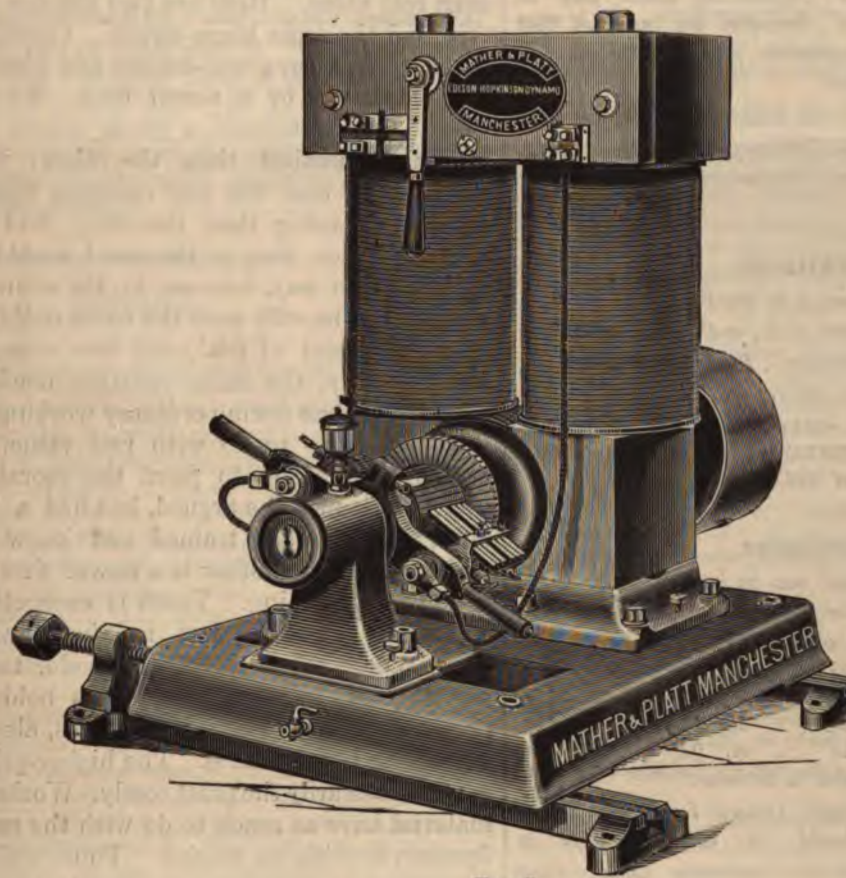

Fig. 7.

The electric current for operating the car motors traverses, as already stated, a conductor of steel channelling placed midway between the rails. The "picking-up" arrangement, by means of which a sliding connection is maintained between car and line conductor is shown in Fig. 4, where A represents a wrought-iron angle bracket bolted to the underframe of the car; B is a block of hard wood bolted to A, the bolt itself being insulated by a piece of indiarubber tube; C is a wrought-iron frame hinged to B at C^1, C^1; D represents a cast-steel shoe, riveted to C, and replaced whenever worn out at the cost of a few pence; E E are ordinary copper conducting cables with their ends soldered into C, and carefully insulated by indiarubber tubing: they serve, of course, to convey the current to the motor on the car above, being joined as shown. F is the steel channel conductor.

At one point of the line the rails for a short distance have to cross a public highway on the level, and as it would obviously be inadvisable, if not impossible, to employ a surface working conductor, the steel channel arrangement is cut out altogether just here, the circuit being completed by means of an overhead wire with which contact is made by a very simple framework of iron fixed on the top of the motor car.

Fig. 5 shows a train standing on the line at this point—the overhead wire and contact arrangement on the top of the car being clearly visible. Of course, contact with the overhead wire is always made by each car (as it comes to this crossing) before it ceases with the steel channel, and therefore no break in the circuit exists at any time.

Fig. 6 shows in diagrammatic form the general arrangement of switch gear as used on the motor cars. The motors, one of which is illustrated in perspective view in Fig. 7, are of the well-known Edison-Hopkinson type, series wound, and the connections will be seen at a glance from the diagram. The current enters at C C, from the conductor, passing into C S, the car switch. This has a number of bars connected to resistance coils, R C, so that the current circulating through the motor may be varied. Another bar allows the motor to be cut out of circuit altogether. The cables marked E E are, of course, taken to earth on the car rails, which serve in this instance as a return.

For most of the details and sketches in this notice we are indebted to Mr. H. Harrison, the secretary of the company which works the line.

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COMMERCIAL VIEWS IN DYNAMO CONSTRUCTION.

Comparatively little attention has been directed to the comparison of costs of dynamos and similar machines. This, of course, is more a commercial than a scientific question, but it is an important one. Mr. Guy, in another column, has collected together information of an interesting character, which will no doubt be attentively studied. It would perhaps have been more pungent had we felt able to give the names of the makers as well as the curves, but as we do not emulate society papers nor indulge in personalities, we are content to give the information without the sting. There is a phase of the question, however, which the curves of Mr. Guy cannot elucidate, and which is as important, if not more so, than the cost in its relation to output. We have a distinct recollection, many years ago, before dynamos were thought of, in going past the long avenue of portable engines shown at the Royal Agricultural Society's meeting, hearing a well-known authority reply to a question as to real value per pound expended. He said in effect, The cheapness or dearness of a machine can hardly or never be determined from its cost price. Two of these engines may be almost or quite identical as regards price, size of cylinder, length of stroke, pressure of steam, and yet one shall be, and probably is, doubly as dear as the other. You cannot too often nor too long drum this fact into the minds of purchasers. They to far too great an extent buy from initial cheapness rather than real value. Here are two engines of the same type and the same horse-power. Carefully examine them. One is by a well-known and highly-respected firm, the other by a newer firm. A casual glance shows little difference, a closer shows that one is far better finished than the other; a still closer would show that the one contains better material and workmanship than the other, and though the price is higher, that is the one I should advise any purchaser to buy, because in the course of a very short time he will save the extra outlay in less repairs, less cost of coal, and less strong language. Emphatically, the most valuable machine is that which costs less during ordinary working, and buying price has little to do with real value. The same authority went on to point the moral in another way. This firm, he argued, has had a long experience, its men are trained and know their work thoroughly. The other is a newer firm, and thinks it knows everything. Youth is energetic and competitively pugilistic, but nothing stands against experience. What we want to do, to cut a long tale short, is to assert that what holds good with portable engines or other machines, also holds good with regard to dynamos. The higher-priced dynamo is not necessarily the most costly. Workmanship and material have as much to do with the real value of a dynamo as with an engine. Thus, while it may be interesting to have these comparative curve values, it is necessary to go further and examine workmanship and material before buying. By-and-by, in the days of our grandchildren, no doubt someone will be able to write a true history of a few dynamos, to state first cost, work had out of them, cost of maintenance and other information, to prove which was the best machine; at present we must buy with only a portion of this knowledge, and should give more care to selection. We have the theoretic and calculated efficiency of machines, we have the factory determined efficiency, and these are usually good, but what everyone would like to know is the efficiency under ordinary working conditions. Many engineers are old fashioned enough to determine accurately from three, six, or twelve months' coal consumption, oil, waste, and labour what they term the working efficiency, and few among these men admit so high an efficiency as is claimed by makers. It is in working efficiency that materials and workmanship tell more than anywhere else, and constitute the real saving and the real value. We have during the past session to congratulate the Institution upon the greater practicality of the papers read and discussed, but we venture to think that some other means of discussing commercial questions is desirable. The London Chamber of Commerce meetings hardly give what is required, more perhaps because it restricts its work so much to the consideration of relations existing between the Board of Trade and the industry. Such consideration is necessary, but, as we say, there seems something more wanted between the Institution and the Chamber of Commerce. For example, it has gone forth to the world that one of the problems for Chicago is to obtain uniformity of practice. We think such a problem is not for Chicago to decide, and have said so; but there is no organised body representing industrial electricity to say, the less you interfere with these business questions the better we shall like it. Suppose the congress at Chicago suggest every dynamo with a given output to be such a size, and so constructed, and sold at such and such a price. This is uniformity with a vengeance—a universal specification; and what about workmanship?

REVIEWS.

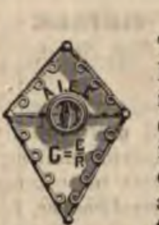
The 1893 Catalogue of the General Electric Company, Limited.

The issue of a complete and reliable price-book is of general interest to the electrical and engineering trades. It is of much more importance than the issue of a mere trade catalogue. Although what a few years ago was known by this name did not merit or receive a review, it is very different with a work like the present. Electrical engineering is an industry, and therefore deeply concerned with prices. The vast field it covers is well exemplified by the scope of this book. The descriptions, illustrations, and prices range from central-station plant to heating appliances, telephones, and bells.

These form an interesting record of the progress of applied electrical science. The 400 quarto pages contain 10,000 illustrations and over 50,000 prices. To be of value as a current price-book the accuracy of prices must be above question, and this has been secured. In addition to its use as a price-book for all electrical appliances, it will be found most valuable as a reference book. The diagrams and data are full and corrected by the best authorities and latest published results. In this way its value to consulting engineers, electricians, and architects is enhanced. All who are interested in electricity will find the book of the greatest interest as a handbook to the practical side of electrical engineering.

A noticeable feature is the care with which all parts have been standardised so that interchangeability and uniformity can be assured. This is kept before the mind of the reader by displayed type and headlines, and is a step in the right direction, the importance of which it is hard to over-estimate. The catalogue contains everything which is known in connection with the applications of electricity, the latest appliances, and the best in each of their respective classes. Only a supply house with enormous facilities could command the means and ability to carry through the production of such a work. This has not been produced by mere compilation, but has been written from the beginning in the best form. Taking the book as a whole, we fail to see any reason to envy our trans-Atlantic brethren in the matter of catalogues when such a one as this is published in our midst. The work forms a very handy and reliable compendium and current price-book for engineers, electricians, and architects—indeed, for all who are allied with the electrical industry. It is interesting to note the signs of the times in various ways given in this book. Take as an example incandescent lamps. We are informed that the present monopoly exists till November 10, 1893, and that the publishers of this volume are making preparations for the erection of a large factory for the production of incandescent lamps in England. It will not become us to criticise such action, but we venture to say, walk slowly rather than hazard too much. There are other patents which will act for a time in favour of the present holders. Still, one of the valuable features of this catalogue is in the general information, apart from the price-lists, it gives. To buyers far away from the centres of manufacture, some of these diagrams and hints will be invaluable, and should make the book one of constant reference. Estimates of complete plants are given, but a word of caution should be given not to take such estimates as more than approximate. Prices do vary a little, and while an estimate may be pretty exact at the moment of writing or publishing, a change of price of some of the constituent items will make a change in the total. We again commend this catalogue to all buyers and users of electrical apparatus.

BADGE FOR AMERICAN ELECTRICAL ENGINEERS.



The official badge adopted by the American Institute of Electrical Engineers, which we illustrate herewith, embodies a number of electrical characteristics. In the first place, it is in the form of Franklin's kite which demonstrated the identity between lightning and electricity, and represents static electricity. It is a recognition of America's first electrician and philosopher, Benjamin Franklin. Then it contains a diagrammatic representation of Wheatstone's bridge, one of the most important pieces of electrical testing apparatus. The galvanometer in the centre is another equally important piece of testing apparatus, and represents magnetism and induction. The galvanometer is made of amber, representing, of course, the first conception of electricity dating back to 600 years B.C., when Thales, the Greek philosopher, recorded the fact that amber, when rubbed, attracted light particles to it, and the Greeks worshipped it, believing the gods had endowed it with life and that it possessed a soul. In 1600 A.D., Dr. Gilbert, court physician to Queen Elizabeth, coined the word "electricity" from the word "elektron," the Greek name for amber. The letters A.I.E.E. represent the initials of the American Institute of Electrical Engineeers; while $C = \frac{E}{R}$ is the formula for Ohm's law—the fundamental law in electrical work. The pin is made of white enamel with the lettering and front portions in 18-carat gold and the back in 14-carat gold. It is sold to members at 3dol. each.

The badge, we may mention, was designed by Mr. W. J. Hammer. The institute has been endeavouring to secure a pin or badge for over four years, as all the American scientific societies have their special badges. All the designs hitherto submitted have been rejected, so that Mr. Hammer is to be congratulated on the success of his idea. It is to be used as a sort of trade-mark for the institute, and a steel plate has been made to be used on official documents.

OBITUARY.

THE LATE SAMUEL ELKINS PHILLIPS, F.C.S.

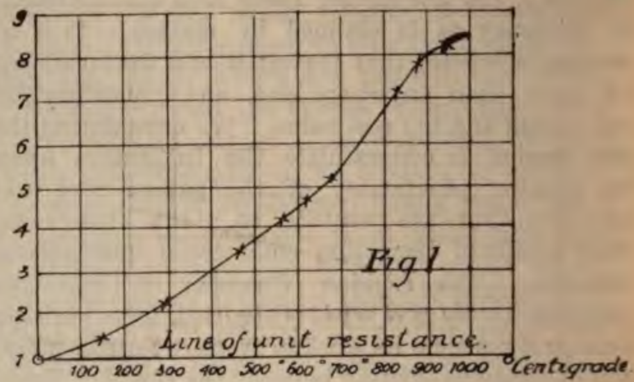
We regret to have to announce the death of Mr. S. E. Phillips, of Reading, in the eightieth year of his age, who died at his residence in the Wokingham-road on May 23, and was buried in the Reading Cemetery on the 27th. Mr. Phillips was an active worker in the pioneer days of cable work. His first active connection with electrical matters dated from the early days of the first Atlantic cable project, when he became associated with the late Dr. Whitehouse, whose assistant he was for some years. Later on he was appointed superintendent of the Benghazi station on the Malta-Alexandria line—Malta, *viâ* Tripoli and Benghazi. Subsequently returning to England, he was appointed one of the superintendents who went out with the Persian Gulf cable. During the term of his three years' agreement with the Government he was for the most part of the time in charge of the Bushire station After his return from Persia he did not take any active part in electrical matters, except occasionally to write for the technical journals. As our readers know, the *Electrical Engineer* was one of the favoured journals. The only work he ever published was a small volume on "Old or New Chemistry," in which was combated some of the modern notions which failed to find favour with the author. In electrical, as in chemical matters, the late Mr. Phillips held some very decided views, and refused to act as a weather-cock following every new suggestion. The tendency of the day towards continuous change was looked upon as unscientific, and he preferred the older views unless the strongest possible reasons were advanced for change. As a man and a friend it would be difficult to find one more beloved—kind-hearted, cheerful, and genial, his was an ever-welcome face and voice—and his many friends will long mourn the loss of his sympathetic ear.

PRACTICAL APPLICATIONS OF ELECTRICITY TO THE HEATING AND WELDING OF METALS.

BY W. H. WATKINSON, M.I.M.E., M.I.E.E., SHEFFIELD.

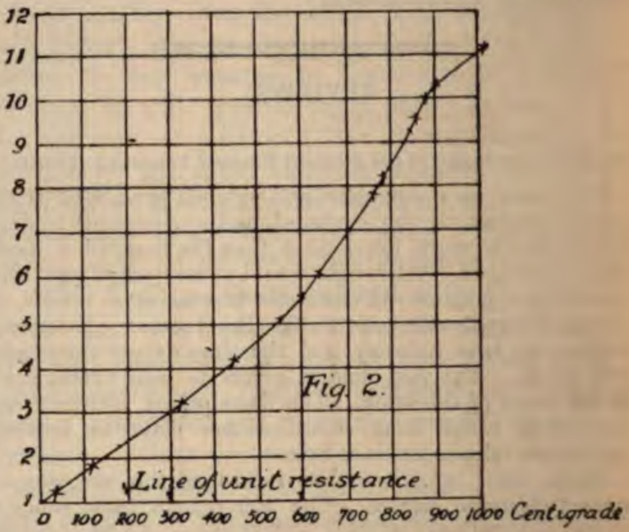
Of all the various and rapidly multiplying branches of electrical engineering, none have developed more rapidly in recent years than electric welding and electric smelting; and of all the branches this is of the greatest importance to the metallurgist, the engineer, and the metalworker, for it enables them to do work which they could not do before, and which cannot be done by any other agency. The electric light is a great boon, but good healthy lighting can be obtained without it. Electric transmission of power is convenient for many purposes, but there are many mechanical means of transmitting power which are active competitors with the electric means. In welding and smelting, however, we can do things by means of electricity which cannot be done in any other way.

It will be a source of considerable pride to the members of this society to know that, so far as I can find, our great teacher, Lord Kelvin, was the first to experimentally demonstrate the application of electricity for the fusing together of metals. My authority for this is a paper by the late Dr. Joule, which he read in March, 1856, on "The Fusion of Metals by Voltaic Electricity," from which the following is quoted: "It occurred to me some months ago that it might be possible to employ the calorific agency of the electric current in the working of metals. By the use of a voltaic battery there appeared to be no doubt but that small pieces of metal could be fused into one lump. If so, it was obvious that by employing a battery of adequate size, the largest masses of wrought iron could be produced, the question resolving itself simply into one of cost. It was not before the last month that I had an opportunity of witnessing an experiment on a small scale. It was performed at the laboratory of Prof. Thomson. He surrounded a bundle of iron wires with charcoal, and, after transmitting a powerful current through it for some time, the wires were found in one part to be completely fused together. More recently I have made several experiments, in which the wires were placed in glass tubes surrounded with charcoal, etc. With a battery of six Daniell cells I have thus succeeded in fusing several steel wires into one, uniting steel wires with brass, platina with iron, etc." Joule then proceeds to estimate the cost of this method of fusing metals, and one of the results he arrived at is that to melt 1lb. of iron in this way would require 5,000 grains of coal to be burned in the furnace of a boiler, the steam-engine driving a magneto electric machine.



In 1865 Dr. Joule described his process of hardening steel wires for magnetic needles by the aid of the electric current. The wire to be hardened was held stretched between the ends of two iron rods bent into a semi-circular shape. The free ends of the iron rods were placed in connection with a voltaic battery by means of mercury-cups. Underneath the wire to be hardened was placed a trough of mercury, and when the wire was heated sufficiently by the passage of the current it was suddenly immersed in the trough of mercury, the current being at the same instant cut off.

The methods of generating large currents of electricity were, however, at that time of far too costly and troublesome a nature to allow of these discoveries being applied on a large scale, and without our present efficient dynamos electric welding and electro-fusion would be still confined to the laboratories of the physicist and metallurgist.



In this short paper I have not time to go more fully into the history of the subject, and must now go on with its elements. You all know that whenever a current of electricity flows through a substance the energy expended in overcoming the resistance to the flow of the current is converted into heat, and if the current be sufficiently large, the substance can be raised to a white heat or fused, and even vapourised. The only limits to the temperature which can be obtained in this way are due to radiation and conduction of the heat generated, and, with a given potential difference, the limit due in the case of metallic substances to the increase of the resistance with increase of temperature. This increase of resistance due to increase of temperature is of great importance in the

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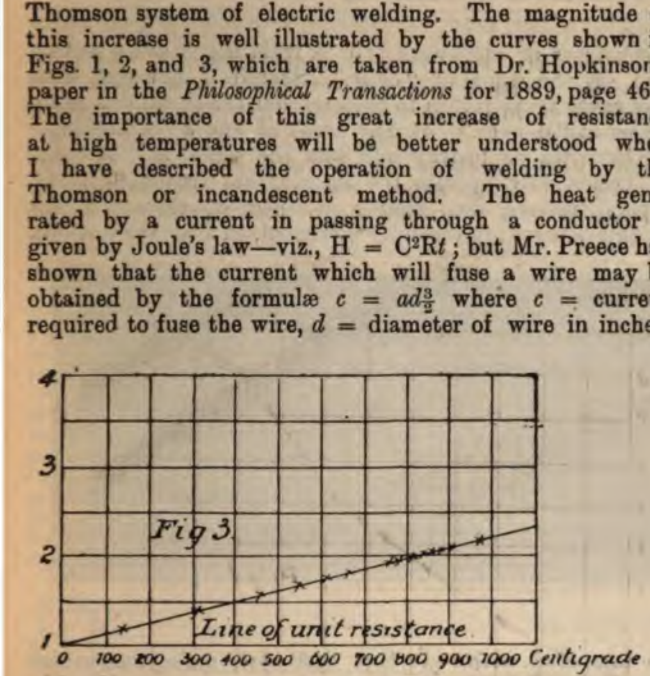
* Paper read before the Physical Society of Glasgow University.

Thomson system of electric welding. The magnitude of this increase is well illustrated by the curves shown in Figs. 1, 2, and 3, which are taken from Dr. Hopkinson's paper in the *Philosophical Transactions* for 1889, page 462. The importance of this great increase of resistance at high temperatures will be better understood when I have described the operation of welding by the Thomson or incandescent method. The heat generated by a current in passing through a conductor is given by Joule's law—viz., $H = C^2Rt$; but Mr. Preece has shown that the current which will fuse a wire may be obtained by the formulæ $c = ad^{\frac{3}{2}}$ where c = current required to fuse the wire, d = diameter of wire in inches,



a = a constant, for any given material, to be found by experiment. The following table gives the values of this constant obtained by Mr. Preece with bare wires 6in. long:

Material.	Value of "*a*."
Copper	10,244
Aluminium	7,585
Platinum	5,172
German silver	5,230
Platinoid	4,750
Iron	3,148
Tin	1,642
Alloy (lead, 2; tin, 1)	1,318
Lead	1,379

The numbers in this table represent, of course, the number of amperes required to fuse a rod 1in. in diameter of the different metals given. These numbers do not, however, represent the current necessary for welding by the Thomson method, owing to the great amount of heat conducted away through the clamps between which the rods are held.

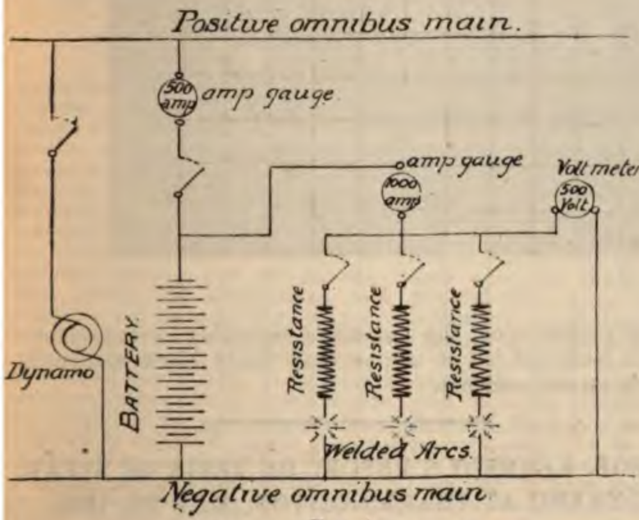


FIG. 4.

Another fact which should be mentioned is that an iron wire which will fuse with a direct current of 122 amperes will only require 92 amperes to fuse it when the current is alternating.

The three principal systems of electric welding at present in use are—the arc system, patented by Benardos in 1885; the incandescent, or Thomson, system, patented by Prof. Elihu Thomson in 1886; and the Coffin system, which is a modification of the other two.

In the Benardos system the heat due to an electric arc formed between the metal being operated on and a rod of carbon held in the hand of the operator is employed to fuse the parts together. The temperature of the electric arc is higher than that of any other available source of heat, and the experiments shown indicate how wide are its applications, and how simply it may be applied. [Experiments shown: (1) Cutting out pieces of sheet metal and of sheet asbestos; (2) the fusing together of two pieces of sheet metal; (3) of a piece of wire to a piece of pumice stone (4) of a piece of wire to a piece of asbestos; (5) filling up a blowhole in a steel casting.]

It is in connection with the last kind of work that the Benardos system is most extensively employed at present. By it, costly steel castings which would otherwise be rejected owing to unsoundness in some of their parts have, after the faulty part has been fused away, pieces of special steel fused into the defective parts; and when this is properly done the castings are rendered perfectly sound, and the part fused in is undistinguishable from the rest of the casting. Its strength is also undiminished or diminished so slightly that the castings are passed as sound by the surveyors of the Admiralty and Lloyd's. I know of several firms which have been saved hundreds of pounds in this way since they adopted this system. The range of work which can be done by the arc method is indicated by the following list of repairs which have been effected by it: 20-ton crankshaft, defect remedied and passed; steel rolls, broken through the necks, after repair, carried weights of four tons; a patch put on the boiler of a steam crane in constant work since; a silver cream jug.

For boring and cutting out, the arc is of great value where plates and girders have to be cut to definite lengths or forms. It is possible in this way to do as much work in one hour as could be done with a cold sate in 10 hours. Fig. 4 shows the diagram of the connections used in welding by this method.

(To be continued.)

AUTOMATIC ELECTRIC RAILWAY SIGNALS.

We gave in our issue of April 28th an account of a system of automatic railway signalling which has been developed and perfected by the Automatic Electric Railway Signal Company, of 11, Rumford-place, Liverpool. An extremely interesting working model is shown at 39, Victoria-street, Westminster, which a number of electrical, signalling, and railway engineers have inspected. The system has been applied on a small scale in the Isle of Wight; and as a really practical and economical system of automatic signalling—that is, one by which the trains themselves clear or block the lines—is greatly desired by railway men, it will be well to give some technical particulars of the apparatus used.

The general appearance of the signals and automatic switchboxes is seen from the perspective view, Fig. 1, taken from a photograph, as actually erected on the line mentioned.

Fig. 2 represents one of a double line of rails with three block stations, which may be at any required distance. The arrow represents a train moving in the direction indicated. The weight of the train depresses a spring connected to a contact in the upright boxes seen in Fig. 1; these break an electrical contact and work a relay which moves the signal. The train in Fig. 2 has passed signals 1 and 2, both of which it has placed at danger. (These two being at the commencement of the line do not require any second treadle, there being no signal in advance of them.) On the arrival of the train at No. 3 it depresses treadle C, connected with the contact breaker, A, the upper part of which is insulated, thus breaking the electric circuit, and, in consequence, releasing the tongue of the relays, H and I, one of which controls the local circuit and allows the signal arm and spectacle to fall by gravity to "danger." Immediately after this the train depresses treadle C, connected with the contact maker, B, thus completing the electrical circuit through the upper part of B, which is of brass, to the relay, I; the line wire battery, G; relay, H; and to earth, E.

This causes the armature of the local relay to be attracted, and thus places signal No. 1 at "clear." As the contact made by B is only momentary, the relay I is so arranged as to cut out B when the circuit is completed, and introduce a fresh earth, E. The mechanism for actually moving the semaphore and spectacle is contained in D on Fig. 3

Fig. 3 is an enlarged diagram of the electrical connections of signals 1 and 3, which work in conjunction, but it will be easily understood that the signal No. 4 might in the same manner be connected with No. 1, if it was considered necessary to have more than two sections blocked against the passage of trains. The battery power required is very small, and it will be clearly seen that any failure of the battery or breakage of the line will at once stop the electrical action, and allow the signals to fall to "danger" by the force of gravity.

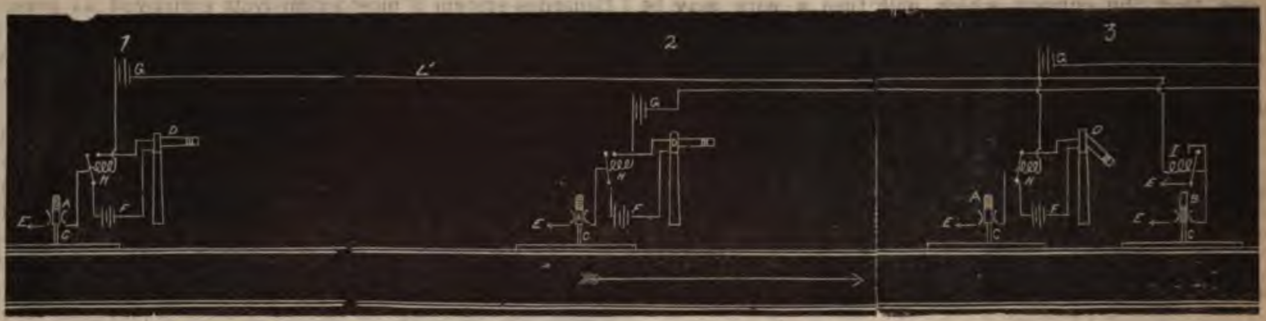


Fig. 2.

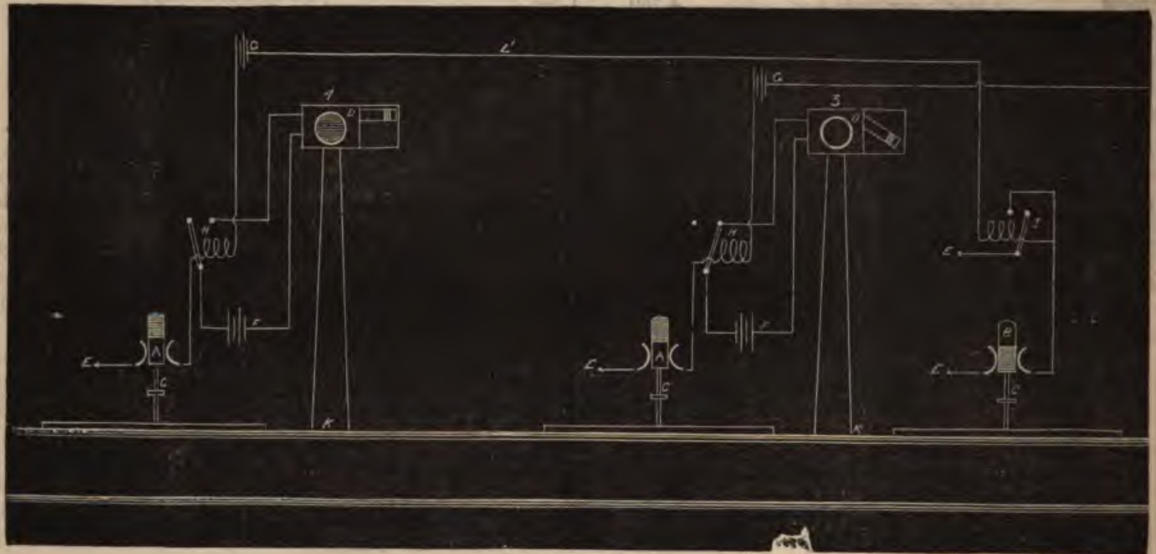


Fig. 3.

An important addition to the system in the neighbourhood of large towns, such as London and suburbs, would be the use of a fog bell, which can easily be made to ring continuously when the signals stand at "clear." These fog bells could be switched in or out of circuit by the signalman.

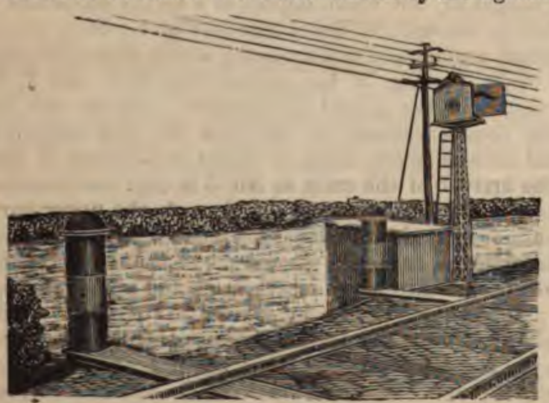


Fig.

The advantages claimed for this automatic system are: 1. The action is entirely automatic. 2. Great simplicity in construction and detail; entire absence of complicated mechanism or clockwork. 3. A train may leave a section and set the signal at "clear." Should it, however, from any cause again return to such section, the signal will again be set at "danger." 4. Any break of line wires, accidents to batteries or instruments, sets the signal at "danger." 5. Trains only operate the signals, the passing of platelayers' trolleys, etc., having no effect on them. 6. All working parts are carefully protected, so that they cannot be tampered with. 7. Low first cost, maintenance also low, and a saving in wages consequent upon a considerably reduced staff. 8. Single lines may without difficulty be blocked in both directions. 9. Sidings cannot be opened until the main-line signals are at "danger," and *vice versâ*.

We should be pleased to hear of tests or practical applications of this interesting system. The public will feel greater security if it knew that some of the great responsibility in blocking trains were taken from the signalmen and placed upon the automatic signalling arrangements that could not fail to act, or that would block automatically on any accident.

PROF. KENNEDY'S REPORT ON TESTS OF STEAM DYNAMO AT THAMES DITTON, MAY 20, 1893.

The dynamo tested was a continuous-current shunt-wound machine, with drum armature, made by Messrs. J. H. Holmes and Co., of Newcastle, and marked by the makers No. 673. It was driven direct by a Willans engine (No. 1,430) of the I I type—compound and condensing. The nominal full output of the dynamo was 1,025 amperes at 120 volts, or 123 kilowatts. The machine was first run at this output for six hours continuously, and during this time electrical measurements were made at regular intervals to ensure the uniformity of the load Sets of indicator diagrams were also taken, and the water consumption measured. The mean output during the whole six hours' run was 1,010 amperes at 120·0 volts, or 121·2 kilowatts, being thus practically equal to the nominal full load. At starting, the speed was 332 revolutions per minute, which, at the end of the trial, had only increased to 337 revolutions per minute. The shunt current was 14·5 amperes at start, and then fell slightly, remaining steady at 14·0 amperes during the last half of the experiment. The energy expended in ıgnetising the fields was thus less than 1·4 per cent. of the whole tput. During the time when the condensed steam was being easured, the mean output was 1,010·5 amperes at 120·2 volts, ıich amounts to 121·5 kilowatts, or 162·8 e.h.p. The condensed eam amounted to 3,314lb. per hour, which corresponds to 23 3lb. r unit, or 20·3lb. per electrical horse-power hour. The indicated rse-power at the same time works out to 190·2, so that the com- ıed efficiency of engine and dynamo (ratio of electrical output at rminals to indicated horse-power) reaches the very high figure of ·6 per cent. The steam used per indicated horse-power works out to ·4lb. All these figures represent, as will be seen, the working of the namo and engine at a load just below its nominal output. As on as the six hours' run was over, and the dynamo stopped, I serted a thermometer with a small bulb well into the end of the nature, as I always do in these tests, where it attained in a few nutes a maximum temperature of 132·5deg. F. The temperature the air between the dynamo and the engine was 80·5deg. F., so at the interior of the armature was 72·0deg. F. above the tempe- ıure of the air, after having completed its six hours' run. The e of temperature, if measured on the outside of the armature, uld, of course, have been much less. I made, later on, efficiency d steam-consumption trials at three-quarter, half, and quarter tput, and measured the steam also for running the machine cited and light, and also for running the engine alone, e armature being uncoupled. The dynamo was run at proximately the same speed in all cases, and the vacuum was o kept constant, its value being 24·5in. of mercury (the ometer stood at 29·9in.) throughout. No doubt with a higher cuum even better results could be obtained. The detailed ures of all these tests are given in the appended table. Their ults are also shown graphically in the diagrams which company this report. In Fig. 1 the base of the diagram is ctrical horse-power, and on this base are drawn curves of licated horse-power, total water per hour, and mean working essure reduced to the area of the L.P. piston. The observed points clearly indicated in the diagram, and it will be seen that four points in each set lie very closely upon one straight e. From the observations thus rectified the curve of ciency and the curve of water per indicated and per electrical rse-power hour are worked out, and are plotted on the diagram. satisfactory point of special importance is the slow rise of the t-named curves, even as far back as half load. This matter, wever, rather affects central-station work than the probable ure duty of this particular machine. In Fig. 2, the base of the gram is indicated instead of electrical horse-power. I have rked here, on the line giving the total water per hour, the nts which correspond to the observed quantities of water used hour when the engine was running with no load, but at full eed. In Fig. 2 I have given also a curve showing the percentage the total indicated horse-power which is expended at each load useless work—*i.e.*, in overcoming the frictional and other ernal losses of the engine and the dynamo. The ordinates of s curve are, of course, in reality no more than the difference ween 100 per cent. and the corresponding ordinates of the ciency curve of Fig. 1.

The electrical and other measurements were made upon the ndard instruments of the Thames Ditton Works, which are w accepted by all engineers, I believe, as accurate. The steam d was all weighed in a tank placed on a standard weighing- chine, after having been condensed in a surface condenser. I ieve this to be the most accurate method of steam determina- n which has yet been practically carried out. As to the general haviour of the dynamo, I can only say that it ran absolutely rklessly throughout the whole of the trials, and gave no sign any trouble whatever. Taking together the high efficiency of set, its good results as to temperature and sparklessness, and its small consumption of steam per electrical horse-power, it takes its place with only three or four others quite at the head of the very large number which I have tested.

ALEX. B. W. KENNEDY.

19, Little Queen-street, Westminster, May 24, 1893.

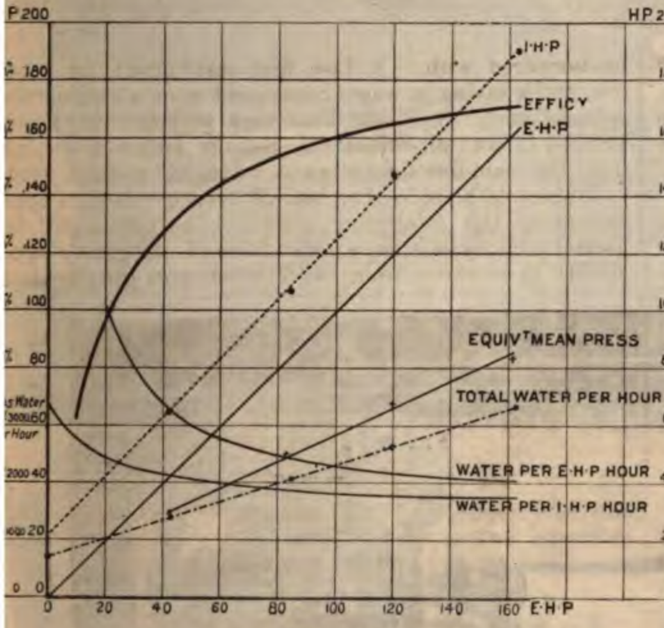


FIG. 1

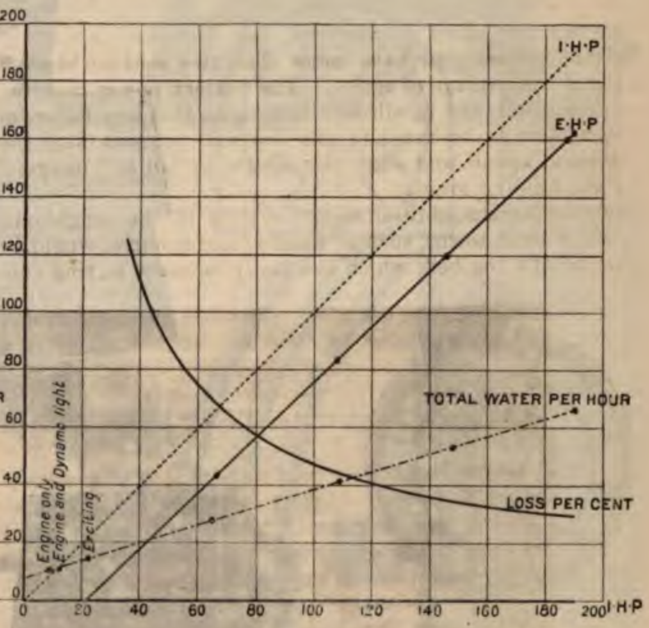


FIG. 2

TABLE GIVING THE PRINCIPAL RESULTS OF OBSERVATIONS DURING THE EXPERIMENTS.

Conditions.	I.H.P.	Current amperes.	E.M.F. volts.	Kilowatts.	E.H.P.	Revs. per minute.	Exciting current. Amperes.	Water used per hour. lb.
Full power	190·2	1010·5	120·2	121·5	162·8	339	14·0	3,314
Three-qrtr. power	147 5	746·0	120·5	90·0	120·0	334	12·8	2,631
Half power	108·8	523·5	120·1	62·9	83·9	336·5	11·1	2,048
Quarter power ...	65 0	263·0	120 2	31 6	42 1	338	10·5	1,384
Excited	—	—	120 0	—	—	346	9·5	722
Light with dyn'mo	—	—	—	—	—	343	—	580
Ditto armature uncoupled	—	—	—	—	—	340	—	524

ADDITIONAL FROM J. H. HOLMES AND CO.

From cards furnished by Messrs. Willans and Robinson, taken when the engine was running disconnected from the armature, but at a slower speed, so as to get more accurate reading, they find the mean pressure (reduced to low pressure) to be 4·5lb. This cannot be far wrong, for we have—

External circuit.. 85·6 per cent.

Engine itself $\frac{4.5}{42\cdot6}$ .... 10·5

Dynamo excited.. 4·0

or otherwise

Engine efficiency $\frac{42\cdot6 - 4\cdot5}{42\cdot6}$ .... 89·5 per cent.

therefore dynamo efficiency $\frac{85\cdot6}{89\cdot5} =$ .... 95·6 per cent.

JOEL PATENT ALTERNATING-CURRENT MOTORS.

The construction of these alternating-current motors is the result of many years of experimental investigation. The many difficulties in dealing with alternate currents—the inductive action, different frequencies, difference in phase in parts of one and the same circuit, magnetic reluctance, and other well-known peculiarities—have been met, and to a great extent overcome.

The fields of these motors are made of the very best soft iron in thin sheets of No. 28 or 32 gauge, one of the special features being the making of laminated field magnets, punched in one piece, with poles and cores complete. Fig. 1 is one type. Fig. 2 is a side view, and shows a number of thin punched plates, bolted side by side, so that various sizes or powers of motors can be made of punchings of one size; the armature is also made of laminated iron punchings, cut out from the central piece left after punching the field-magnet frames, thus obtaining economy in materials. Fig. 3 is a four-pole type stamping, and for some motors a four-pole field has been made by dividing the shaped field shown at Fig. 1 at the dotted lines, using two separated field electromagnets punched in a complete form as described.

A novel type of magnet core both for field magnets and armatures has been recently invented by Mr. Joel. The field-magnet cores are entirely formed of the best quality of fine soft iron wire; the whole frame, magnetic cores, poles, and polar extensions are made of a quantity of fine iron wire wound upon a suitable former, and either worked into shape on the former itself as it is being wound, or a flat ring or some suitable shaped coil is first formed, and then the whole is worked by pressure into the required shape. There is no after-tooling required: the whole frame is made at once, and simply requires fixing in position. A complete magnetic frame, such as Fig. 1, is made by first winding a flattened cylindrical-shaped ring of iron wire, and then working the coil of iron wire over a mould or between moulds. A U-shaped magnetic frame is made by doubling a ring coil upon itself and then working it into shape; any shape of magnetic frame can be made. The armatures are also made in a similar manner, and Pacinotti toothed shaped armatures, all of iron wire, are moulded and worked between toothed rolls to form projecting teeth all of one continuous band or toothed wheel of iron wire, ready for winding the conducting wire coils—the object of both of the very thin stampings and the soft iron wire being to obtain the greatest possible electromagnetic action, with the minimum of magnetic inertia; and as is well known, this is the desideratum for alternate-current motors—it is the keynote to a successful motor. The special arrangement of conducting and magnetising coils follows, and is dependent upon the electromagnetic quality of the iron. The efficiency of the motor is also dependent upon the quality of the iron; the loss in solid-iron cores from hysteresis, and in motors depending for their action upon magnetic lag, is avoided by this construction.

Many types of alternating-current motors have been made by *Messrs.* Henry F. Joel and Co., and the following is a description *of some of them: The motor* shown in Fig. 4 is built up with the punchings shown at Fig. 1; these are bolted to base-plate. The armature is also made with punchings, having Pacinotti tooth-shaped projections of an unequal disposition round the armature to avoid all dead points and determine the direction of the revolutions. The armature is supported, and runs in two coned-shaped bearings, the body of which forms a waste-oil receiver. The armature is wound with a continuous coiling, the fields in this special motor being wound inductively. The brushes are of carbon. A motor of this type is fitted and in active work driving a machine workshop, as in the illustration Fig. 5, taken from a photograph. This motor weighs about 85lb. It is self-starting with a load run at about 1,000 revolutions per minute, and reverses at any speed. It is used to drive the shafting and machine tools, which would otherwise require a ½-h.p. gas-engine. We have seen this motor in actual work. The motor can be adjusted for speed and power by means of an adjustable resistance.

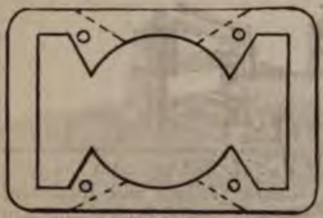


FIG. 1.

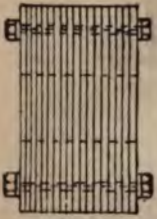


FIG. 2.

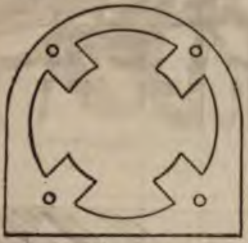


FIG. 3.

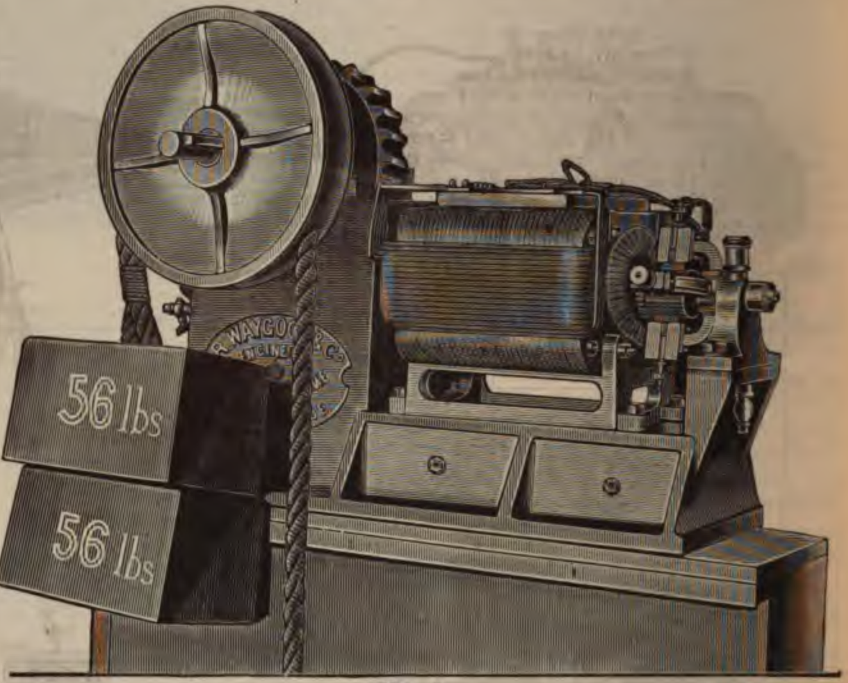


FIG. 6.

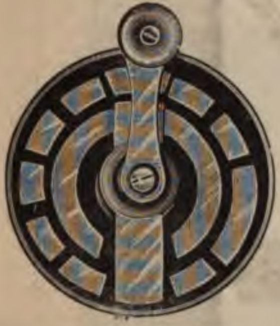


FIG. 7.

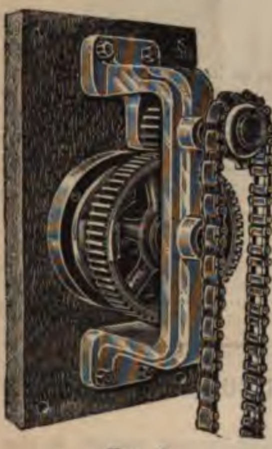


FIG. 9.

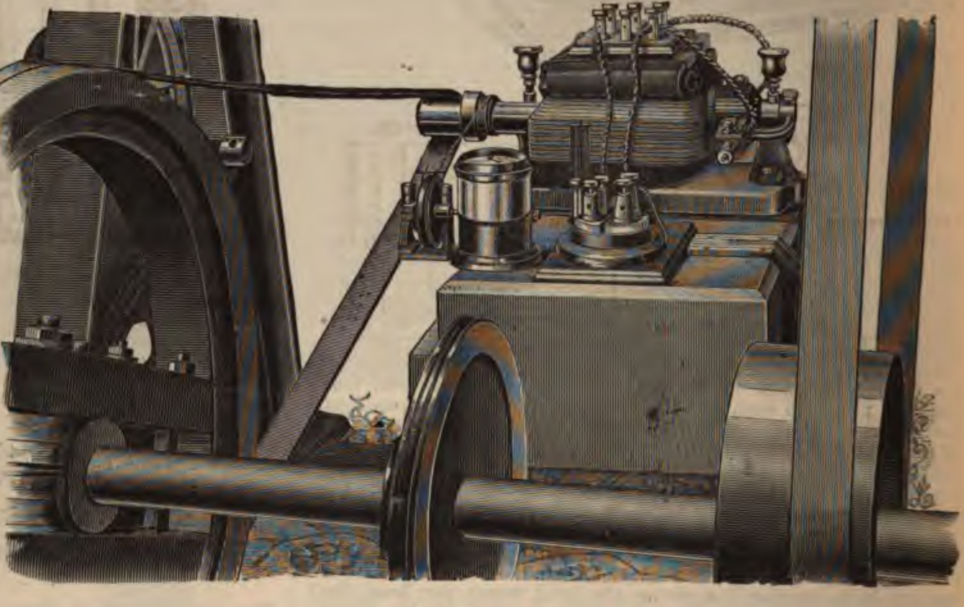


FIG. 5.

Another example of a Joel alternating-current motor is shown in the illustration, Fig. 6, taken from a photograph. This motor is for practical use for a small lift, such as is used for domestic housework, dinner lifts, etc., and it was designed to exactly suit the purpose. Considerable torque was required, and for a small motor the power is great. It starts with a load of 90lb. in either direction, and will run with considerably over 1cwt. The motor is specially made with four-pole with two separate magnet fields, as shown in dotted lines Fig. 1. The motor is specially mounted and attached to the lift gear, the armature draws a pinion geared to a worm wheel, as shown. The motor runs at about 800 revolutions per minute. It reverses, and, as is very necessary in lift work, it is adjustable.

In order to enable this motor to work with varying loads, a specially-designed commutator switch is used. A front view of this switch is shown in Fig. 7, and a diagram of the electrical

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SUSPENSION WHEELS.

SIR,—In your obituary notice of the late Mr. E. A. Cowper, whose loss we all very much regret, it is stated that he invented the modern suspended wheel for bicycles. I have not the least wish to detract anything from the numerous inventions of Mr. Cowper, but I may be permitted to mention that suspended wheels were invented and made by William Worby at Ipswich not much less than 20 years before the date assigned to Mr. Cowper's invention, and in 1867 he gave me a pair of what he called his suspension wheels for a tricycle I was then about to make.—Yours, etc., W. WORBY BEAUMONT.

London, May 29, 1893.

COST OF COOKING BY ELECTRICITY.

SIR,—The error in my letter published in the *Electrical Engineer* of May 19th, of stating "one quart" instead of "one pint," is so palpable that every engineer must have known what was meant. The heat units generated by the current, mentioned at 100 volts, would boil about 1·3lb. of water at 60deg. F. in 10 minutes, but allowing for loss of heat, one pint could easily be boiled in this time. I do not, however, consider that the ordinary forms of kettles, saucepans, etc., are the most suitable for electrical heating; even the gas engineers have accustomed us to large flat-bottomed apparatus not previously employed. I am now making a new type of boiling arrangement specially suitable for use with electric heaters, which will, I believe, be a great advance on all others.

It is interesting to hear from so eminent an authority as Mr. Thomas Fletcher, that coal cannot be compared with electricity. This is exactly my opinion. Just as gas, when used for boiling purposes, affords many advantages over coal, so electricity will outstrip its rival for heating exactly as it is doing for lighting. It is not my intention to enter into a long controversy upon the merits of electricity in its latest phase, for this is unnecessary. The enquiries and orders we have in hand are sufficient proof of the public interest in this new departure. It is a mistake to consider that the expenditure of a few pence extra in cooking a dinner will deter those who have electricity available from using electrical cooking, particularly when it can be shown that the food is cooked in an absolutely pure atmosphere, and in the most perfect manner. There is no doubt that the old adage of "The proof of the pudding is in the eating" comes in with greater force in the present instance than is often the case. Full particulars of trials will be published shortly, and I prefer to let these speak for themselves rather than discuss the theoretical possibilities of using electricity in this direction. The cost of using the apparatus is, of course, an important item; but I am satisfied that wherever the current is sold at a reduced price during the daytime, when most cooking operations are carried out, it can be used in competition with many other forms of apparatus now employed.

I remember some 10 or 12 years ago that we were treated to long articles in journals interested in gas supply, *proving conclusively* (so they said) that electricity could never be supplied at a price that would be cheap enough to bring it into use for lighting purposes. The same thing is now happening with regard to the use of electricity for cooking and heating purposes, but as current is not only available, but in extensive use at the present time, I have no fear that as soon as the advantages of electrical cooking and heating are known, electricity will be used for these purposes also.—Yours, etc., H. J. DOWSING.

TRADE NOTES AND NOVELTIES.

THE MESTON ALTERNATING-CURRENT MOTORS.

We continue our description of this interesting system, commenced in our issue of May 19, and now illustrate the new slow-speed type of motor, which motors have been specially designed for driving all classes of small machinery, such as sewing-machines, knife and boot cleaners, washing-machines, cream separators, small lathes, coffee mills, dental drills, small electric pumps, and a host of other useful appliances of a kindred nature. This motor is self-starting and self-regulating, and will work at variable speeds according to requirements. We learn from the agents that they are supplied in two windings, for working on 50—52 and 100—104 volt circuits. It will be observed in the duplex type that two motors are mounted on one base and geared to a single countershaft, thus producing twice the power of the single type of motor. The countershaft is geared to the motor shaft to give from 200 to 280 revolutions per minute, the motor itself running at variable speeds from 2,000 to 2,500 per minute.

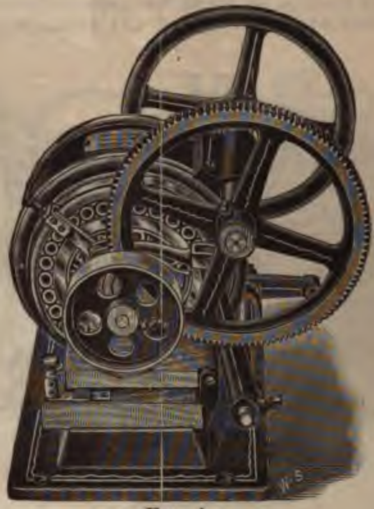


FIG. 1.

They have self-oiling bearings, and in order to prevent the splashing and throwing of oil about (which is a great fault, and so detrimental to the adoption of some types of self-oilers), the inventor has designed an arrangement which may be briefly described as follows: Just below the shaft in each bearing, provision is made for a small oil-well or reservoir, which is filled with cotton wool or other absorbent packing; this becomes thoroughly saturated in the oil, and the packing, by gently pressing against the "under" side of the shaft, provides just enough oil for its continuous lubrication, but not enough to spatter about, and all that is required is about once a week to supply the well with a few drops of oil through the oil-hole above the shaft. All the working parts are entirely enclosed in an outer shell finished in polished bronze and black enamel. The polished bronze castings which serve as bearings for the armature shaft are artistic in design, and yet strong and substantial. The armature, which is built up of specially-prepared laminated iron, has no wire winding thereon whatever. The parts are, however, easily accessible, as the two end covers are removable, and therefore, if desired, the armature can be taken out at any time, cleaned, and examined, without disconnecting any of the wires or disarranging any adjustment of parts. We have only been able to superficially examine the construction of the new Meston motor, but the designs seem original and novel. Probably one of the most important features in the new type of motor is the construction of the regulating and reversing device, which enables the motor to rotate at any speed according to requirements. By sliding a button either to the right or left the motor can be reversed at will, an arrangement which is very useful when the motors are used for working air-propellers or exhaust fans for

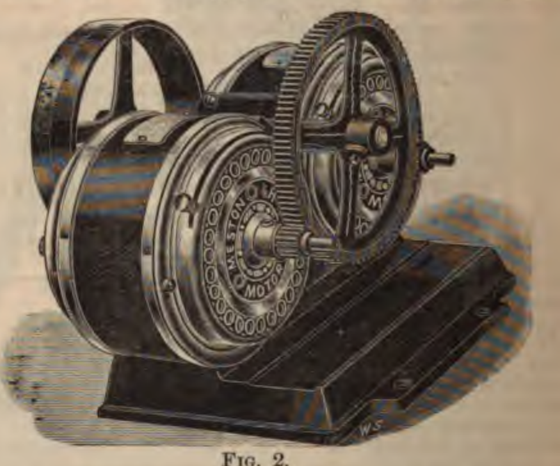


FIG. 2.

200 of the selected cars, and these tenders have now been received, varying from £144 to £176 per car. The selected cars were electrically lighted, hence our interest in them. The deputation is to visit the works of the various tenderers and report.

Cardiff —At a meeting of the Cardiff Lighting Committee, held at the Town Hall on Wednesday in last week, Alderman Carey presiding, a letter was read from Mr. Massey, electrical engineer, suggesting that the Board of Trade should be approached with reference to the time fixed by the provisional order for the supply of electric lighting. It was resolved that as the Board of Trade will hold an enquiry before revoking the order, no steps be taken.

P. and O. Service.—Mr. B. Arkell, who was appointed electrician to the P. and O. Company's ss. "Shannon," which sailed for India on May 18, qualified himself for the post at the electrical and general engineering works of Mr. Ronald A. Scott, M.R.I., M.I.E.E., Acton Hill, W. The fact that this is the fifth appointment given by the P. and O. Company to members of these works, while others have been accepted and placed on the list, is substantial proof of the good experience gained at the Acton Hill Works.

Fleetwood. — The Electric Lighting Sub-Committee of the Fleetwood Commissioners are on a tour of inspection on the invitation of a well-known firm of electrical engineers, who defray all expenses of the journey. The tour is for the purpose of gaining information on the subject of the electric light, the adoption of which as an illuminant is under consideration by the local authority of Fleetwood. It is understood that the committee will in no way be bound to the firm whose guests they are, but the action taken by the committee has been unfavourably criticised.

Telephone Amalgamation.—The National Telephone Company has gone another step forward in its policy of amalgamation, having now absorbed the Telephone Company of Ireland. The actual cash invested in the Irish company is £61,197; the National agree to pay £81,300 for the assets, waiving any claim to participate by reason of £87,500 ordinary shares, which it holds in the Irish concern. Holders of debentures and preference shares will be paid off, leaving £15,000 over to be divided amongst ordinary shares. The Ulster district already belonged to the National Company.

Bury. —The Lancashire Bury—not that of St. Edmunds—has an enterprising Corporation which desires to receive tenders—to be accompanied by specifications and reports—for the erection of an electricity station to carry out their provisional order. Saturday, the 15th of July, is the limit of time for preparing the tenders. It will be questioned by many whether the Corporation have done a wise thing in giving free scope to those desirous of tendering, or whether they should not rather have called in a good consulting engineer who might draw up complete specifications. However, the experiment will not perhaps do any harm, if no good.

London Chamber of Commerce.—A meeting of the Electrical Trade Section is to be held at the offices to-day, at 3.45 p.m., when a full attendance is particularly requested. The business is: to consider position of overhead wire regulations up to date of meeting; to consider a motion, notice of which has been given, that a special committee of the Section should be appointed with power to raise funds and take such other action as may be necessary to promote the interests of electrical traction; to consider the desirability of representations being made to the Railway Association that a special rate should be granted for the carriage of electrical wire and cable; other matters.

Tullie House.—The Building Committee of the Free Library and Museums Committee have accepted the tender of Messrs. Latimer Clark, Muirhead, and Co., Limited, Regency Works, Westminster, amounting to about £1,450, for the installation of the electric light at Tullie House. The tender does not include the foundations and the masonry and joinery work, but it includes gas-engines and the provision of duplicate plant as a safeguard against accident The accepted tender was the lowest of about 24 by all the principal firms in the country. Messrs. Latimer Clark, Muirhead, and Co. have recently installed the electric light at the North-Eastern Hotel at York, which is reported to work exceedingly well.

Worcester Workhouse.—At the meeting of the Worcester Board of Guardians, Mr. Bennett said that the figures guiding the committee in their decision not at present to adopt the electric light were unreliable. It was said that the estimated cost of putting in the electric light for the new workhouse would be £600, and the estimated cost of gas would be £150, but the number of electric lights was, in his estimate, put at nearly double the number of gas lights, which made it an unfair comparison. Mr. Rowe, architect, said that complete specifications, both as to the installation of the electric light and the supply of gas, had now been received. The subject was referred to the Building Committee for further consideration.

Chatham.—At last week's meeting the Mayor stated that the annual accounts of the local electric lighting company were laid before the Council, if any member would like to see them. In reply to Councillor Mitchell, the Mayor said the company were compelled to lay the accounts before the Council by Act of Parliament. The Mayor pointed out that there was a clause in the Act which empowered the Council to fix the time when the company's servants should open the "traps" in the pavements in the High-street. He considered that something should be done to enforce those powers, and he promised to bring the matter before the Council at the next meeting. Under present conditions, tradesmen had their business greatly interfered with.

Cost of Gas-Lighting in Liverpool.—An interesting comparative return as to the expense involved in lighting the city during each of the past 12 years has been prepared at the direction of the Finance Committee of the Liverpool Corporation. It appears that the amount expended has increased from £29,140. 8s. 6d. in 1881 to £41,920. 6s. 5d. last year, while the estimated amount for this year is £42,475. The great increase was from 1881 to 1883, and was due to the introduction of court-lighting. For the past five years there has been an increase of about £1,200 owing to the increased lighting hours, while two years ago the advanced price of gas caused an increase in the lighting charge of £1.5C0, this having increased to double the amount last year and in this year's estimate.

Pumping Plant.—The Shilbottle Colliery Company, of Ledbury, Northumberland, have placed a contract with Messrs. Ernest Scott and Mountain, electrical engineers, Newcastle-on-Tyne, for an electrical pumping plant for their colliery. We hope at the completion of this installation to give an illustration of these pumps and dynamos, but in the meantime we may state that we are informed that the installation will consist of a compound-wound Tyne dynamo, constructed to give an output of 25,000 watts at an E.M.F. of 500 volts, a main switchboard, with measuring instruments, between 1,200 and 1,300 yards of concentric lead-covered and protected cable, and a set of three-throw pumps, with 25-h.p. motor, the pumps to deliver 200 gallons of water per minute, against a head of 185ft.

City Lighting.—At the meeting of the Commissioners of Sewers last week, Mr. Morton brought under the notice of the court the fact that the Press Association premises in New Bridge-street, which had been fitted at great cost, remained unlighted by electricity, and he asked why the private electric lighting in the City had been so long delayed. Mr. Morton concluded by moving that the company should be communicated with on the subject. The motion was adopted. It was also resolved, on the motion of Mr. Johnson, to instruct the Streets Committee to prepare a report upon the subject of laying telephone tubes in conjunction with the electric lighting arrangements. It was also decided, on the motion of Mr. Barham, to communicate with the electric lighting company on the subject of the space it was utilising in the City for transformer stations.

Aberdeen : Engineer Required.—At a meeting of the Gas Committee of the Town Council held last week, Mr. George Farquhar, convener, presiding, it was agreed, by a majority of five to four, to recommend that the electric lighting account be opened with the Union Bank. A long discussion took place on the question of the appointment of an engineer to take charge of the electric lighting department. It was agreed that an engineer should be appointed, but there was considerable difference of opinion as to the conditions. Treasurer Bisset proposed that the committee should recommend that an engineer be appointed to act under Mr. Smith, the gas manager, and Mr. Bain seconded. Mr. Skinner proposed that the engineer be responsible directly to the Gas Committee. This was seconded, and ultimately this proposal was carried by five votes to tour. It was agreed to recommend that the salary of the engineer should be £200 per annum.

Brighton Switchboard. — The following are the tenders received for the supply and erection at the electricity works, North-road, of a central-station switchboard and apparatus, for the Brighton Corporation :

Fowler, Lancaster, and Co., Birmingham	£3,459	0	0
Laing, Wharton, and Down, New Bond-street, W....	3,388	0	0
Gulcher New Electric Light Company, Battersea ..	2,480	0	0
Johnson and Phillips, Old Charlton......	2,414	6	0
Poole and White, Limited, Bread-street, E.C.........	2,248	12	6
Crompton and Co., Mansion House-buildings, E.C...	2,231	0	0
Latimer Clark, Muirhead, and Co., Limited, Regency-street, S.W..........................	1,750	0	0
Thames Ironwork and Shipbuilding Company, Limited, Orchard Yard, Blackwall, E	1,300	0	0
Siemens Bros. and Co., Queen Anne's-gate, W.	1,230	0	0
Goolden and Co., Harrow-road, W. (accepted)........	800	0	0

Fire-Alarm Bells at Margate.—The installation of the electric bell system for ringing up the firemen in the event of an outbreak of fire at Margate has been completed. At present only a portion of the brigade is included in the circuit, and the other members will be called by messenger. On the receipt at the police station of an alarm of fire, the constable on duty has only to set a pendulum swinging to cause the bells at the superintendent's house, the fire station, and the residences of the men to ring simultaneously. The chief constable's house is to be connected with the police station by telephone. It is stated that the maroon, or some other means of quickly calling out the brigade in the daytime, will still be used, but people will be spared the alarm occasioned by the maroon being fired off in the middle of the night. A further improvement would be a couple of fire-alarm posts at the two extreme ends of the town—namely, Cliftonville and Westbrook—by which much valuable time would be saved in acquainting the police of an outbreak in either of those districts.

Fire Apparatus in Belfast.—The Belfast Mechanical and Engineering Association opened their summer session on the 27th inst. by visiting the fire brigade station and main drainage works. About 40 of the members assembled at the City Hall. The party was conducted to the fire brigade station by Mr. Lindsay and Mr. J. C. Bretland, city surveyor, where the members were introduced to Superintendent Parker and his staff, and first witnessed a complete turn out of one of the machines, to which the horses were harnessed and sent off in 35 seconds. A pressure of 100lb. was raised from cold water at the start in 10¼ minutes in the new fire engines. The various machines, ambulance waggon, electric apparatus, and new buildings in the course of erection were lucidly explained by Mr. Parker, after which an exhibition was given of how the fire escape is manipulated. Belfast has been very backward in fire brigade work for long, even, we believe, leading to the insurance companies refusing to take risks except at enormous rates. We hope a new state of affairs has now fairly started.

Southport.—At a special meeting of the Southport Town Council on Tuesday evening, an excited discussion took place in regard to the electric lighting scheme for the borough. There was a full attendance of members, and the trouble arose upon the question of what area should be included in the electrical installation. The committee propounded a scheme for covering the town area, or in the streets chiefly occupied by shops, but embracing the promenade. It was elicited that this would cost some £14,000, whilst the original and larger scheme of the Corporation would cost £34,000. Several speakers described the action of the committee as degrading and dishonourable, and the members were twitted upon having spent six months doing practically nothing. An amendment that the original scheme be carried out was only lost by a majority of three votes, and a further amendment in the same direction was defeated by two votes only. The city fathers sat until after 10 o'clock, but the committee carried their resolution, and it was understood that the Council will be furnished with a report, showing the respective advantages and disadvantages of a town site and of the gasworks site.

Bristol—An Exhibition Proposed.—Mr. Charles Wills presided at a meeting of the Bristol Electrical Committee on Tuesday, when a communication was received from Messrs. Durnford and Sons, contractors, asking for an extra allowance in consequence of unforeseen difficulties encountered in laying the foundations of the central station, Temple Backs. The committee did not accede to the application. Mr. W. H. Preece informed the committee that the works were well in hand, and would be completed within three months. Mr. Proctor, who has been acting as clerk of the works, was appointed resident engineer, at a salary of £5 per week, and of the 40 applicants for the post of assistant engineer, at a salary of £2. 10s. per week, the choice fell upon Mr. A. W. Rankin. The question of lighting the exhibition buildings was discussed, a suggestion having been made that in addition to supplying the current, the committee should undertake special lighting in the Fine Arts Department, illustrating the varied uses to which the electric light can be applied. Mr. Levy suggested that the chief electrical engineering firms would be glad to take part in an exhibition of that kind, and the chairman, with Messrs. J. T Board and M. Levy, were appointed to consult with the committee of the exhibition on the proposal.

Electric Cranes for Wool Warehouses.—Electricity is rapidly coming into favour as a motive power for occasional or intermittent use in Bradford; for instance, in the working of cranes or lifts in wool warehouses, where, although the power is wanted comparatively seldom, it must be always instantly available. The directors of the Union Warehouse Company have recently fitted up the whole of their great blocks of buildings with cranes to be worked by electricity from the Corporation mains. Hitherto the cranes have been worked by hydraulic power, but the severe frosts of the past two or three winters have proved most destructive to the plant. The plan now adopted is that of Mr C. E. B. Holt, of Bradford, who applied it successfully to a crane at the warehouse of Messrs. Fisher and Fox more than 12 months ago. The shaft of an ordinary friction crane in the attic is driven direct by a belt from a dynamo or motor. The novelty of the arrangement consists in the gear for starting and stopping the motor. This is done by a switch of peculiar construction, the design of Mr Holt. The switch is in the form of a quadrant with a radial arm, and the movement is effected by a wheel and worm gear worked by a rope running through all the eight floors of the warehouse so that the motor can be started and the crane set to work from any floor. All shock is ingeniously avoided both in starting the motor and in breaking the circuit when stopping the machine. Mr. Joseph Clark, of Laisterdyke, has supplied the cranes, and Messrs. Crompton and Co., Limited, the motors, 20 in number.

Edinburgh.—Mr. Colston, on behalf of himself and others, at the meeting of the Town Council on Wednesday, entered reasons of dissent and protest against the electric lighting system being managed by the city. Mr. Colston said he would have obtained signatures, but the gentlemen had not turned up The clerk read the reasons, which were in effect that electric lighting was still in its experimental stage; that great losses had been sustained in working electric lighting schemes; that electric lighting was not a necessity like a water or gas system; that it was admitted by the supporters of the resolution that electric lighting during the first year would not pay; and that the Corporation should have ascertained the conditions on which a company would have given supply. The reasons were adhered to by Bailie M'Donal and Messrs. James Robertson, George Auldjo Jamieson, T. A. C. Mortimer, John Murray, W. S. Brown, D. M. Dunlop, and R. Cranston. Bailie Macpherson asked if these gentlemen had paid their shilling. Mr. Colston said he had paid on behalf of himself and all who might adhere to him, and he questioned whether the clerk was entitled to take the shilling, not being a notary public. Mr. Auldjo Jamieson said that while he had signed the protest he desired to say for himself, and he was sure for the other signatories, that they were anxious now to afford their colleagues the utmost assistance in carrying out the scheme. Bailie Gulland said the best answer to the protest would be that the committee would work the thing so successfully that a great many of the fears stated would be removed.

Llangollen.—At the last meeting of the Local Board a committee consisting of four members was appointed to consider the question of supplying electric light for the town. During the past few months Mr. J. P. Davies has collected together a mass of useful and interesting information upon the subject, and has been in communication with a number of well-known electrical engineers. The committee, which consists of Messrs. J. P. Davies, H. O. Thomas, J. E. Jones, and J. E. Griffiths, has held one sitting, with the result that they are convinced of the practicability of the proposed scheme. Mr. Brayne, engineer, of Liverpool, attended the committee and gave an interesting and practical report of the several schemes which might be adopted for obtaining the necessary motive power. After a thorough survey of the district, Mr. Brayne has come to the conclusion that a spot on the River Dee immediately above the Llangollen Flour Mill is the most advantageous. This proposal involves the construction of a weir across the river at this point, which will provide a sufficient fall of water. The estimated cost of this portion of the undertaking is put down at £800, while £1,600 will be required for the actual lighting. The project of constructing a weir on the spot indicated is not a new one, inasmuch as suggestions have from time to time been made in that direction. At that time, however, the proposal had not the remotest reference to the question of electric lighting, but was intended to provide boating facilities for the town. This would commend itself to the favourable consideration of the public, and if this scheme could be also utilised for the production of electric light there would then be a twofold advantage in its adoption. It is understood that the members of the committee visited the spot indicated by the engineer with the result that practically they are unanimous as to its feasibility, and as to recommending the adoption of the report by the Board. Before the next meeting of the Board the Company's surveyor from Liverpool has undertaken to meet the members of the committee and to draw out detailed plans and estimates of the undertaking.

Progress at Niagara.—The special correspondent of the *Glasgow Herald* at the World's Fair visited the new water-power works at Niagara. This, he reports, is certainly the most gigantic engineering enterprise for the generation of power that has ever been undertaken. The company is in a position to draw off such an amount of water as will develop 100,000 turbine horse-power. This is only between 1 and 2 per cent. of the total water horsepower of Niagara Falls, and when the proposed works are in full operation no perceptible difference will be caused by them in the appearance of the falls—not so much change as is probably caused by natural weather influences within a few hours in any one day. The water is taken by a series of sluices from the rapids half a mile above the falls. Here four long wheel-pits are to be constructed, one of which is now nearly completely excavated. In each of these pits is to be placed five turbines, each of them developing 5 000 h.p. The first set of five turbines is now being finished in the works at Philadelphia, and it is to be hoped that by next spring they will be in operation. From the wheel-pit the water is led away through a great tunnel, graded to an incline of 7·10 per cent., 7,000ft. long, 19ft. wide, and 21ft. high, to be discharged once more into the Niagara River below the Falls. This tunnel is already finished, the connections between it and the first wheel-pit being in process of construction. It is by far the biggest subterranean watercourse that has ever been built, and to the eye of the engineer the view along its arrowy straight length is in the highest degree impressive. It was cut from three points, the lower end and two intermediate shafts sunk specially for this purpose. The mechanical power developed by the turbines is to be transformed into electrical power by gigantic alternate-current dynamos of novel construction, one dynamo being mounted directly on the top end of each turbine shaft The power will be distributed electrically for lighting and motive purposes all over Buffalo, and over a new industrial town which the company proposes to create upon 1,800 acres of land which it has acquired for the purpose. Already one paper-mill taking 3,000 h.p. has been erected, and others will surely follow speedily.

Aberdeen Mechanical Society.—The following remarks on electric light show the attempts being made to popularise the subject by giving elementary information. This may not always be quite accurate when subjected to the scrutiny of those fully acquainted with the subject, but it is the kind of information we want to see permeate into every household. These remarks are from a paper by Mr. W. Smith, of Aberdeen: "The ideal light produced is the sun; therefore the ambition of all lighting engineers must be to devise a light as like it as possible. Electric light has come nearest the ideal in all points except one, but that point is worst of all—namely, price. The price of sunlight is the ideal; and twice the cost of gas is far from that. But let us begin at the beginning and see if, considering all things, we have not in the electric light a luminant unprecedented in general convenience. Davey, best known as the inventor of the miner's safety lamp, was the discoverer of the fact that the separation of two carbon points through which a strong voltaic current is passing produces an electric arc of great brilliancy. This was in 1800. No practical use for the light was, however, found till the year 1858, when it was used with an electro-galvanic apparatus to supply night light to the workmen laying the foundations of the Westminster Bridge, London. A contemporary journal states that though the light was rather flickering, it nevertheless enabled the men to get on with the work. and was compared by them to the light of the full moon. With a primary battery, however, the production of electric light is both troublesome and expensive. The invention of the dynamo has made the electric light of all the practical value that it is. The two carbon points between which the arc is formed gradually waste away by the carbon at this high temperature combining with the air. In this way, very soon the distance between the carbons would become so great that the current could no longer leap across, and the light would go out. A piece of mechanism has been invented to overcome this difficulty. It consists of two arrangements of clockwork, one for separating the carbons, the other for bringing them together, and constitutes an arc lamp. These wheels act on the carbon-holders by racks and pinions. The current before reaching the carbons passes through an electromagnet, which attracts the end of a lever, the other arm of which is balanced by a spiral spring. To this lever, just above the fulcrum, is fixed a long T-shaped vertical arm. Both systems of clockwork act through little wheels with long cogs. The T-shaped end is set just between those two, and in such a position as to hold both. Now, to begin with, let the carbons be touching. If a strong current passes through the electromagnet, and the end of the lever is attracted, thus moving the T end of the vertical arm so as to release the cog wheel on the opposite side of it from the magnet. This sets on the separating motion. Again, when the magnet gets weak by the carbons being too far apart, the lever is pulled back by a spring and the T-end releases the other wheel, thus letting on the feeding motion. Jablochkoff invented a method of street-lighting in which mechanism was dispensed with. He placed the carbons side by side with a layer of plaster of Paris between them. Then, when the arc was started by connecting the ends of the carbons with a little bar of the same material, the plaster of Paris was raised to a glowing white heat, which gave out the light. The positive carbon, however, wastes twice as fast as the negative, so when alternating currents are not used the positive carbon is made twice as thick as the negative. The reason for the positive carbon wasting twice as fast as the negative, and also the peculiar form assumed by each—namely, conical and hollowed—is never very clearly understood but perhaps the following theory may explain it: The theory that the positive current takes the inside of a conductor, and the negative the outside, has lately been demonstrated. Let us say, therefore, that the positive current comes out at the middle of its carbon, and the negative from a circle round the point of its carbon. Now, when the particles immediately under the action of the current are volatilised by the heat, they pass along the path of the current. This at once explains the shape the carbons take. The heat generated at both points is probably equal, but the heated surface of the negative point is the outside of a cone, while the inside of the hollow is the heated surface of the positive. The latter, therefore, does not radiate away so much heat, volatilises more carbon, and thus wastes sooner. The fact that the positive is much brighter than the negative would also seem to back up this theory. For lighthouses, searchlights, etc., the arc lamp is unsurpassed, but for house-lighting it is impracticable; "it dazzles, but does not illuminate." The great convenience offered by a low candle-power electric lamp induced inventors to spend time and money in seeking it, but it is found almost impossible to construct an arc lamp below 500 candles. An alternative method was therefore hit upon, and the heating effect of the current on a wire of high resistance was brought to perfection for lighting purposes by Messrs. Edison and Swan, in the well-known Ediswan lamp. It consists of a looped thread of carbonised bamboo fibre, suspended in a little glass globe by two platinum wires. When the connections are fixed to the platinum ends the carbon filament glows with white heat. The candle-power is settled by the thickness of the filament, and can be varied from one to some hundred candles. Many thousands of these lamps are being used all over the world, and although they do not last for ever, that is, perhaps, more the fault of the imperfect means of manufacture than the principle. Of the many advantages electric lighting gives, I will mention but a few. No matches are required. "You press the button, we do the rest." The poisonous gases given out by gas and other lights where flames are used are altogether avoided, always a consideration in the way of medical bills. Electric light is much more pleasant to the eyes than gas, and does not fade flowers so readily. I myself believe that it is more economical, for not only is insurance against fire cheaper in an electrically-lighted house, but "with ordinary care" (an experienced electrician tells us) "the use of a bedroom electric lamp need never exceed 200 or 300 hours per annum, and although this estimate may be thought low, it should be remembered that the electric light need only be used when required, as the ease of switching it off and on makes us forget all our past troubles in hunting for gas taps, matches, and our broken glass globes."

PROVISIONAL PATENTS, 1893.

MAY 23.

10205. **Electric steering gear.** Frank Lewis Dyer and Leonard Huntress Dyer, 1, East-parade, Leeds. (Complete specification.)

10207. **Improvements in electrodes for arc lamps.** Albert Cooper Seibold, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10218. **Improvements in methods of regulating the distribution of electricity and in converting its energy into that of light.** Reginald Wood, 17, Gower-street, London.

MAY 24.

10242. **Improvements in telephonic apparatus.** Charles Adams-*Randall*, 1, The Avenue, Bedford-park, London.

10283. **Improvements in and connected with the manufacture of electrode plates for secondary batteries.** Julius Emil Hofmann, 6, Lord-street, Liverpool. (Complete specification.)

10298. **Improvements in dynamo-electric machines.** William Brooks Sayers, 46, Lincoln's-inn-fields, London.

10304. **Improvements in lighting and extinguishing electric lamps for street-lighting.** Joseph Lobley, 40, Chancery-lane, London.

MAY 25.

10311. **An improved electric escapement to counters, clockwork, and the like.** William Alfred Morrison Brown, 13, Ash-grove, Headingley, Leeds.

10347. **Improvements in or connected with battery switches.** Heinrich Karl Spangenberg, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

MAY 26.

10363. **Improvements in electrically-controlled arc lamps.** Frederick Thomas Schmidt, 9, Clarendon-street, Bradford.

10382. **An improved swit h for electric appliances.** Thomas Edmund Carmichael, 77, Colmore-row, Birmingham.

10396. **Improvements relating to electric conductors.** William Leigh Dudgeon, 4, South-street, Finsbury, London. (La Société Anonyme, John Cockerill, Belgium.)

10398. **Improvements in effecting electrical communication with vessels or buoys at sea.** George Charles Lennox Lenox, 24, Southampton-buildings, Chancery-lane, London.

10399. **An improved frame or holder for the plates of active material used in secondary batteries.** Desmond Gerald FitzGerald, Ernest John Clubbe, and Alfred William Southey, 53, Chancery-lane, London.

10400. **An improved portable battery case and safety device.** Desmond Gerald FitzGerald, Ernest John Clubbe, and Alfred William Southey, 53, Chancery-lane, London.

MAY 27.

10441. **Conduit electric railway.** Edward Thomas Hughes, 38, Chancery-lane, London. (William R. De Voe, United States.)

10452. **Improvements in insulation of electric conductors.** David Cook, 6, Lord-street, Liverpool.

SPECIFICATIONS PUBLISHED.

1890.

20111. **Electrolytic decomposition of metallic salts.** Lake. (Roberts and another.) (Second edition.)

1892.

9799. **Electrolysis of alkaline chlorides.** Fitzgerald.

10022. **Electro-telephonic apparatus.** Grist.

10059. **Electric conductors.** Payne.

10265. **Electrical measuring instruments.** Ayrton and Mather.

11085. **Electrical indicators.** Woodhouse and Rawson United, Limited. (Varley.)

11382. **Making chemical products by electricity.** Niewerth.

11487. **Telephone, etc., poles.** Jeffries.

12731. **Electrolytic extraction of zinc.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

13090. **Incandescent electric lamp fittings.** Hedges.

19738. **Electric safety lamps and batteries.** Edison and Swan United Electric Company, Limited, and Gimingham.

22838. **Telephonic apparatus.** Day. (Haynes.)

1893.

449. **Electric motors.** Storey.

6073. **Arc electric lamps.** Gwynne and Kennedy.

6295. **Electric incandescent lamps.** Stober.

6565. **Dry voltaic cells.** Siemens Bros. and Co., Limited, and Obach.

6579. **Electrically heated radiator.** Mitchell.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6½
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	5¾

An interesting article on the first "Canadian engineer"—the beaver—brightly introduces a first number. There are some suggestive editorial notes, besides descriptive and technical articles, and a wealth of short Canadian notes. The paper should have success, as it fills a distinct place in colonial journalism.

Testing Incandescent Lamps.—A simple method of testing incandescent lamps as to the condition of the vacuum and probable life of the filaments is mentioned in a French paper. As large a number of lamps as possible is arranged on a testboard provided with a rheostat, care being taken only to have at one time lamps of equal voltage and luminous intensity. The lamps are then tested at a low voltage, which allows of those of a darker red than the average being immediately observed. These are noted as doubtful; then current at a higher pressure is passed and the less brilliant lamps noted. Finally, the lamps are energised at from seven to eight volts higher than the normal. Some of the lamps will not withstand this excess of pressure, and it is suggested that they should be returned to the makers. The lamps already noted as doubtful are afterwards run for 24 hours at their normal voltage, at the end of which very few remain intact, and even these cannot, it is said, be relied upon.

British Association.—The next meeting of the British Association will take place in Nottingham during the week commencing Wednesday, September 13, under the presidency of Prof. J. S. Burdon Saunderson, M.A., L.L.D., F.R.S. Nottingham, owing to its central position, the healthy, picturesque situation of the town, and the interesting character of the neighbourhood, is well adapted for a meeting of this kind. Its public buildings afford ample and convenient accommodation for all the needs of that association. The reception-room will be in the Mechanics' Institution, and the various sections will meet in the University College or in rooms adjacent. The principal lace works will be open for inspection, and excursions will be organised to the Dukeries, Newstead Abbey, Lincoln, etc. The president of the Mathematical and Physical Science Section is Mr. R. T. Glazebrook, M.A., F.R.S., and of the Mechanical Science Section Mr. Jeremiah Head, M.I.C.E. Authors should send papers and abstracts before August 16.

Edison Lamp Patents.— In an action brought by the Société Générale des Lampes à Incandescence (owners of the Edison lamp patents for France) against the French concessionaires of the Khotinsky incandescent lamps for alleged infringement, the former lost the case. The Ninth Chamber of the Civil Tribunal of the Seine, in giving judgment, decided that the Edison patents upon which the plaintiffs based their arguments are invalid and of no value, and cannot, according to the previous patents invoked by experts, confer upon the Société Générale the right to claim the exclusive property of an electric lamp consisting essentially of a carbon filament of high resistance contained in an exhausted globe and connected to platinum conductors; and that the Khotinsky filament formed of a paste of amorphous cellulose has nothing in common with the Edison filaments constituted of fibre or fibrous substances. The Tribunal, on the other hand, concluded that it would be an infringement to use for new lamps patented sockets having formed part of old lamps.

The Anabasis of London.—Under this rather curious title Mr. Grant Allen has a very suggestive article in the *Westminster Gazette* for Wednesday. He looks to the time when considerations of health, and greater means of easy access, will lead the people of London to go much farther afield for their residences. The swamps on which the present suburbs are built will be deserted, he thinks, for the heights around—beyond Highgate on the north, and on the Surrey hills. We shall return to dwelling on the hilltops, always more healthy and more pleasant, from sanitary reasons, considerations of fresh air, beautiful walks, and the country enjoyment of the children. Now, most of this revolution in habits—already it is noticeably begun to a large extent—may, we fancy, lie with the electrical engineer. At any rate, it is quite conceivable that he will have a large finger in the pie by the way of rapid electric railways which, when the growing needs are more apparent, will certainly be built for these purposes. There is also the fact that growing suburban towns on the hills—such, for instance, as Haslemere and Kingswood already begin to be—will require laying out, as Grant Allen suggests, with careful regard to convenience, beauty, and sanitation; and the electrical engineer must be reckoned with in the thoughtful planning of any new town. Electricity will certainly help to change the habits of the future citizens, and those who are occupied in the question will read with interest the article spoken of above.

Fault Indicator.—An instrument for automatically indicating the place of a fault on underground conductors has been in use, it appears, for some time in Berlin in a large central station. An alarm is sounded at the station the moment a fault is developed, and the locality is also indicated. For this purpose the usual pressure wires are used, and are so connected that a certain difference of potential exists between the copper conductor and the pressure wire. When a cable is damaged, the short circuit which then occurs between the pressure wire and the copper conductor produces a change in the voltage existing between them, which in turn actuates a relay and an alarm at the station without necessarily preventing the pressure wire from serving its purpose for indicating the pressure. The relay actuates an annunciator, which indicates the position of the fault, the district being divided in squares. Besides this there are ground detectors at the station which show the condition of the insulation, not only of the whole network, but of every single district. The system (devised by the Allgemeine Company, and described by Dr. Kallman in the *Elektrotechnische Zeitschrift*) is based on the fact that the largest part of the loss of potential between the two points connected to earth is at these points—only a small portion being due to the resistance of the earth between the points. The conductors are therefore made to indicate the potential of the earth in the various districts, and by means of relays and voltmeter measurements the locality of the fault can be determined.

Mining in Australia.—A paper on "Electric Mining," by Mr. Brain, read before the Electric Club of New South Wales, raised an interesting discussion. Mr. Callendar said the insignificant list of work given showed how far Australia was behind the world, with a few lighting installations and one solitary sluicing plant. New Zealand was much farther ahead. There is no lack of mines in Australia—coal, copper, tin, silver, and gold. It might be said that it is owing to the deficiency of water power, and undoubtedly the richest mining districts are many miles from water power. But there are many cases where this not so—the Hillgrove mines, for instance. Close by is the large fall of Gara, capable of giving sufficient power to drive all the mining plant in the district. It is not utilised, and the engineers pay £50 per horse-power a year for steam—a great want of enterprise. Major Parrot alluded to the successful use of electricity in recovering the fine gold in the lower washes of gold mines. He further said that from his knowledge of the colony there were many parts where water power was available, and electrical engineers should assist in bringing the attention of mining engineers to the question, especially in the southern districts, where there was almost as much water power as in New Zealand, and adjacent to rich mining fields. He alluded to the Moruya, Tuross, Pambula, and Twofold Bay districts. Mr. Ladley proferred his thanks to Mr. Brain for his paper, and stated that as a result of it he had made arrangements for an electrical pumping plant at Newcastle, Australia. He added that at the Co-operative Colliery they had seven miles of tail rope haulage, and three more is to be added; if anyone would tell them how to obviate this wire rope they would do good to at least one colliery. Mr. Brain, in replying, described, by request, the Atkinson safety cable; but said the necessity for such a cable was imaginary. It was a bogey raised by electrical men. For a cable to spark it was necessary to break it. Now it was an unknown thing for a fall to sever an iron rope in a colliery; therefore iron sheathing met the difficulty entirely.

Phosphor Bronze.—We have before us the very handsome catalogue of the Phosphor Bronze Company, which is well worth the special attention of electrical engineers. The "cog-wheel" brand of phosphor bronze has been in use for 20 years, and the alloy is acknowledged as the most desirable metal for bearings and bushes, slide valves, and straps liable to be worn by friction. A rather cheaper quality has been introduced under the title of the Vulcan brand. Bars rolled cold in phosphor bronze make the strongest and most useful material where strength and resistance to wear are required, as for rods, screws, bolts, and nuts. A further alloy, known as "Bull's metal," is largely used for propellers, spindles, etc., possessing a greater strength than even mild steel. Weiller's silicium bronze for telephone, telegraph, and other electrical purposes is well known, and largely used where resistance to corrosion and great tensile strength is required. Instructions are given in the catalogue for casting the various alloys. Some interesting illustrations are given of propeller blades forged in Bull's metal, and as propellers attached to electric motors of electric launches are now an acknowledged branch of electrical engineering, the efforts of the company to provide the most suitable metal should be noted. With regard to the silicium-bronze telephone wires, some important testimonials are given. "I have watched its action during storms of wind and snow combined," says Mr. W. Fereday Bottomley, "and have found that whilst iron wire formed almost an arc by the blow of the wind, the bronze wire seemed scarcely to get out of a straight line, and that whilst supports carrying iron wire shivered like ship masts, those carrying bronze seemed perfectly steady, although carrying treble the number of wires." The Budapest Telephone Company says that strong sleet is no longer feared. When the ice drops off the wire resumes its normal tension. The disagreeable vibration on the house tops is also almost entirely obviated by the use of silicium bronze wires. A table of weights and electrical resistance of these wires is given in the catalogue. A photographic reproduction is given of an Admiralty pattern torpedo boat, built entirely of phosphor-bronze plates and angles.

Magnetism and the Human Body.—Mr. A. E. Kennelly, of the Edison laboratory, and Dr. Frederick Peterson, of the College of Physicians and Surgeons, have reported to the American Electro-Therapeutic Association the result of their experiments on the effect of magnets on the human body. Experiments were tried on cats, frogs, boys, and themselves. Human and frog's blood failed to show any traces of polarisation, movement, or vibration. In the case of live frogs, no influence of the magnet on the blood cells or the movement of the blood could be found. To test the German theorists' claims that magnetism increases the resistance to conduction in motor nerves and causes paralysis, a small dog was placed in a cylinder between large field magnets and kept there for five hours under the influence of a strong magnetic current. The exposure seemed to have no effect on the dog, and he came out as lively as he went in. Then a boy was placed between the magnets and a magnetic current was turned on. There was no effect upon the boy. The magnetic current was strong enough to balance a heavy bolt in the air and to contract wires of iron and to hold iron chains so strongly that it required the efforts of several men to detach them. Then the experimenters themselves and their men took turns in lying down on a board placed between the poles of a huge magnet with the current alternately turned on and off. One observer would hold the wrists of the subject and take sphygmographic tracings of the pulse. The second observer would observe the respiration, and the operator would turn the current on and off. No changes were observed in the tracings, or in the respiration, or in any other way. One subject held a steel screw in his hands, while he could tell from its attraction whether the current was on in the magnets. He had no sensations of any other kind. The observers concluded that the human organism is in no manner affected by the most powerful magnets known, and that the brain and the nerves get no sensations or impulses from the magnets. They say that it may be possible that some day magnets may be invented where the number of reversals to the second is high enough and the force strong enough to produce effects on the nervous system, but that so far as the experiments show, electromagnetism seems to have no influence whatever upon the human body.

Dead-Weight.—A great deal of the expense of electric traction is due to the effect of the dead-weight of carriage that it is supposed to be necessary to carry. There is first the actual material itself perhaps uselessly expended, there is the added strength and weight of motor required, and the added size of locomotive by reason of these two. Then the added cost of capital for plant, and added expense in maintenance. Now let us put it to the electrical engineers who build electrical railways: Is it really necessary to have all this dead-weight besides the passengers? We must remember that questions of extreme efficiency have only lately had their full play. Hitherto, anything that would stand well and do its work, even if inefficient, was enough. The old coach, with its paraphernalia of springs, trappings, and gilt, was not designed for special lightness nor on the best scientific principles. The railway waggons were but modified coaches, and to-day the influence of the coachbuilders is paramount; and in trams and electric cars the same old fashion of building cars is followed with but little variation. The Pullman car, a marvel of convenience, is also extremely heavy. It is not so with one other carriage now greatly used—the bicycle. Here every endeavour of scientific ingenuity has been expended to obtain lightness of rolling-stock, and 25lb. or 30lb. dead-weight per person is not uncommon. The speeds, moreover, that this apparently frail structure will stand are often nearly 20 miles an hour, and not over smooth rails, but over the usual broad roads. The question may be suggestively asked: If we are going to have electric cars, can we not do away with much of the dead-weight? And possibly the answer might be more satisfactorily solved—we give the suggestion tentatively—if the cars were designed not by coachbuilders, but by those, like the bicycle builders, who have devoted their lives to the reduction in scientific principles, of the dead-weight

A structure, as is well known, need not be less stiff, less strong, if the material is saved where it is not required; and the fact that cars for bearing the weight of so many persons could, if desired, be designed of far less weight should lead those who are considering the electric railways of the future to consider not only the efficiency of their dynamos and engines, not only the equalisation of loads, but the reduction to the lowest limit compatible with safety of the dead-weight to be hauled. We think the question is worthy of study.

The Production of Aluminium.—In some quarters a great deal has been expected of aluminium, but its high price and comparatively restricted production have hitherto prevented its employment for the many industrial purposes for which it has been suggested to be used. The price has, however, during the past year been reduced, but it remains to be seen whether aluminium will fulfil anticipations. M. Ch. Haubtmann, in a series of articles in *L'Electricien* on the electrolysis of aluminium, suggests the establishment in France of small works to produce aluminium, which he considers would be able to keenly compete with large works. He assumes that all works producing aluminium industrially do so electrically, and that in determining the cost price of the metal, motive power plays an important part. It is easy to find in France waterfalls yielding considerable powers, and, including redemption, interest on capital, and maintenance, power could be obtained at £2. 8s. per horse-power per annum. The cost of energy to produce a kilogramme of aluminium would be 4d., and taking raw materials at their present rates and the horse-power hour at ·014f., the cost of turning out a kilogramme of aluminium, excluding general and working expenses, comes to 1s. 4¼d., of which raw materials comprise 1s. 0¼d. and motive power 4d. M. Haubtmann opines that with the existing deposits of bauxite in France, manufacturers could produce alumina and fluoride of aluminium at a less rate than that mentioned. Notwithstanding the great difference between 1s. 4¼d. and 4s. 10½d.—the sale price of aluminium in France—which left a large margin for working expenses and interest on capital invested, certain manufacturers had convinced Parliament that the existence of that industry was threatened by the Swiss, who employed the Heroult process, which was also used by the Société Electro-Métallurgique Française at Froges, and which was soon to be worked on a large scale at Modane, and under more favourable conditions than obtained in Switzerland. The result of the efforts of those manufacturers was the imposition of a duty of 1s. 2½d. per kilogramme on foreign aluminium. M. Haubtmann mentions this as showing that some firms, instead of pushing forward the industry, had intrigued in the lobbies of the Chamber in order to get a prohibitive tariff; but notwithstanding this, foreign aluminium is beginning to be imported, showing that under less favourable conditions the Swiss are doing better than the French. M. Haubtmann considers by the utilisation of the numerous waterfalls of from 100 h.p. to 200 h.p., aluminium could be cheaply turned out in France, and that works of average importance could place on the market aluminium at from 3s. 3d. to 3s. 8d. per kilogramme, or even less, and yet realise a good profit. He therefore suggests the establishment of small works.

Electrical Coast Communications.—Sir Edward Birkbeck, chairman of the National Lifeboat Institution and a member of the Royal Commission on Coast Communications, visited Ottawa on May 19 (says a *Times* telegram from New York) in order to enquire into the Canadian system of electrical communications on the coast for life-saving and other purposes. In a statement made last Friday, he gave an account of the result of his enquiries in Canada and the United States. He said that Mr. C. H. Tupper, the Dominion Minister of Marine and Fisheries, described fully what the Government had done and what it intended to do as soon as the necessary appropriations had been made by Parliament in the matter of making the coast communications as perfect as it was possible to make them in order to meet the ever-increasing trade up the Gulf of St. Lawrence during the season of navigation. The Canadian Government courteously placed the steamer "La Canadienne" at Sir E. Birkbeck's disposal, and he proceeded from the coast of New Brunswick to the various life-saving stations on the Gulf of St. Lawrence as far as the island of Anticosti, near which a large number of coasting vessels as well as mail steamers pass from the Straits of Belle Isle. He remarked that it was of great importance that there the cable and coast wires for life-saving and mercantile purposes and for weather reporting should be of the most trustworthy character. The coast on the north was high and without harbours, and on the south low and dangerous. Leaving Canada for the moment, Sir Edward Birkbeck proceeded to say: "When I arrived in New York, the United States Government, at the request of her Majesty's Government, gave me every facility for a thorough inspection of the life-saving stations and their system of working, as well as of the coast telephonic arrangements generally. Yesterday I inspected the various stations on the coast of New Jersey, and the working of the telephone for life-saving purposes was practically illustrated by one of the officials. Every station within the district I visited, spreading over a coast-line of more than 70 miles, was communicated with by telephone. The wire is carried along the coast from station to station, which is a great improvement compared with the system now being established in England." Reverting to the Canadian service, Sir Edward Birkbeck said: "One of the most striking points in connection with the system at present in force on the coast of Canada is that the various lighthouse-keepers are all practical telegraphists. It is part of their official duty to telegraph twice every day, reporting not only the facts concerning every vessel signalling her numbers, but also any communication which the captains of the passing ships may wish to have reported in the Canadian newspapers. They send to Toronto twice a day full reports regarding the state of the weather. As far as the lighthouses are concerned, the ordinary telegraphic instruments are in use instead of the telephone. The number of first-class hands employed at the lighthouses is in many cases two, and a the most three. Therefore, the objection raised in England that the lighthouse-keepers would not be in a position to use the telegraph or the telephone were they provided falls to the ground. "I was very much struck," added Sir E. Birkbeck, "by the fact that the United States Government disband the staffs at the live-saving stations from May 1 to September 1, with the exception of the stations on the Pacific coast and the Great Lakes. Only one of the officials is kept at each life-saving station during the summer months, but the telephone is still maintained in constant working order, and many commercial and private messages are forwarded throughout the year from the life-saving stations to the nearest telegraph stations for transmission. I purpose concluding my enquiry to-day by a consultation with the principal officials at the office of the life-saving department in New York. The valuable information I have gathered will be reported to the Royal Commission on Coast Communications, of which I am a member." Sir E. Birkbeck will return to England by the Cunard steamer "Campania" this week.

PRACTICAL APPLICATIONS OF ELECTRICITY TO THE HEATING AND WELDING OF METALS.

BY W. H. WATKINSON, M.I.M.E., M.I.E.E., SHEFFIELD.

(Concluded from page 559.)

The plant necessary for welding by this method consists of a prime mover, engine, turbine, etc., a dynamo, together with the regulating resistances, switches, and measuring instruments shown. By using a secondary battery, however, a much smaller dynamo and engine may be employed for any given amount of work. In most works the dynamo is driven, like any other machine, from the shop shafting.

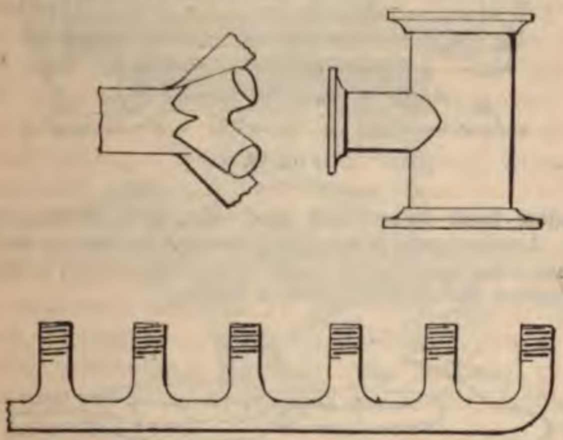


FIG. 5.

At the Coombs Wood works of Messrs. Lloyd and Lloyd this system is extensively used in the manufacture of wrought-iron and steel pipes and fittings. An example of the work done by them is shown on the table, and other examples are shown in Fig. 5. Their plant for this purpose consists of a compound horizontal engine giving 100 i.h.p.; four Crompton dynamos giving a total current of about 500 amperes at 150 volts; a large secondary battery, consisting of 1,800 cells of the Benardos type, one plate of which is shown in Fig. 6. Each of these cells contain nine lead grids about 5in. by 7in., each of which is filled up with lead strips corrugated as shown. From this combined plant a current of 1,500 to 1,700 amperes may be obtained. The regulating resistances are necessary to render the arc sufficiently stable. Messrs. Lloyd and Lloyd estimate that the cost of the work they do by this method is only one-fourth the cost when gaseous fuel is used.

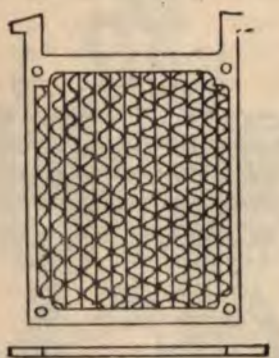


FIG. 6.

The distribution of the current at the Coombs Wood works for the different processes is shown below :

	Amperes.
Gyrating carbon machine	300
Four tables, 200 amperes each	800
One welding lathe..	300
Two mending tables, 50 amperes each	100
Four lead-welders, 15 amperes each	60
Lighting of building	150
	1,710

The gyrating carbon machine is the invention of Mr. Howard, of Messrs. Lloyd and Lloyd, and it is of great service for special work. It is illustrated in Fig. 7.

In order to test the strength of welds made by the Benardos system, Messrs. Lloyd and Lloyd had tested, by Messrs. Kirkaldy and Sons, 210 iron and steel bars of various qualities and sizes which had been welded electrically by men who were not trained blacksmiths; 50 similar bars which had been welded by the skilled smiths of a neighbouring firm were also submitted to the same tests. The following table is a summary of the results of these tests :

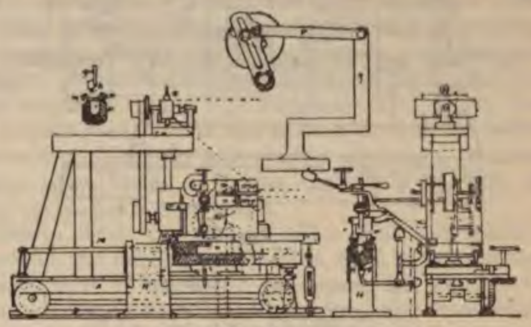


FIG. 7.

Size.	Brand.	Ultimate stress per square inch.	Contraction of area at fracture.	Extension in 10in.	Ratio of weld to solid.	Figure of merit = ultimate strength × contraction of area at fracture.	
in.		tons.					
$2 \times \frac{5}{16}$	Lowmoor	20·3	15·2	7·3	77·9	308	
,,	,, ...	21·1	17·3	7·3	81·1	365	Electrical
$2 \times \frac{5}{8}$	,, ...	21·5	22·3	17·3	90·7	479	
,,	,, ...	21·8	20·7	19·7	91·8	451	Electrical
$2 \times \frac{1}{4}$	Netherton best	18·4	10·1	3·4	84·4	185	
,,	,,	20·1	10·8	4·5	92·0	217	Electrical
$2 \times \frac{1}{8}$	Parkgate steel	20·9	9·3	1·9	69·1	194	
,,	,,	22·3	8·4	3·8	73·6	410	Electrical
$2 \times \frac{1}{4}$	,,	20·4	15·9	8·1	82·3	324	
,,	,,	21·0	15·4	7·3	86·4	323	Electrical
						$\frac{1,766}{1,490} = 118·5$ %.	

The efficiency of the electric weld averaged 88·5 per cent., and of the hand weld 80·8 per cent.

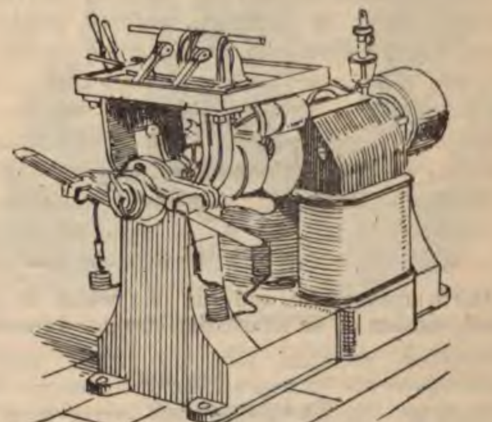


FIG. 8.

Benardos in his patent specification describes several new methods of building up girders, etc., which are rendered possible by means of the electric arc.

Incandescent Method.—The plant necessary for this method may, besides the motive power plant, consist simply of a dynamo constructed so as to give a large current, say, 20,000 amperes at a pressure of 1½ or 2 volts. Fig. 8 shows a dynamo of this type with the welding-table attached. It is obvious that this arrangement can only be used in cases where the welding-table can be close up to the dynamo, owing to the great cost of the conductors which would be necessary to conduct this enormous current a distance of even a few yards.

Another arrangement consists of an ordinary dynamo combined with a secondary battery, the cells of the battery being charged in series and discharged in parallel. For some purposes this is a very convenient arrangement, but has the same drawback as the last method—viz., that the welding-table must be close to the battery.

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* Paper read before the Physical Society of Glasgow University.

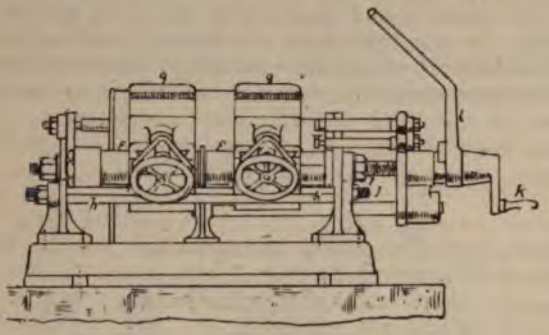


FIG. 9.

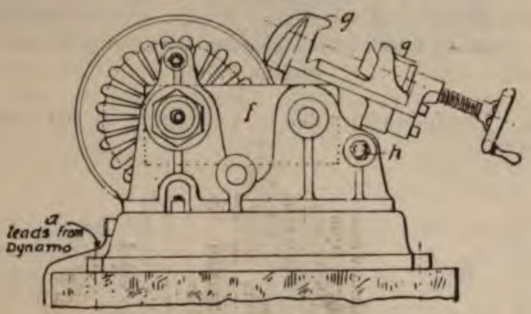


FIG. 10.

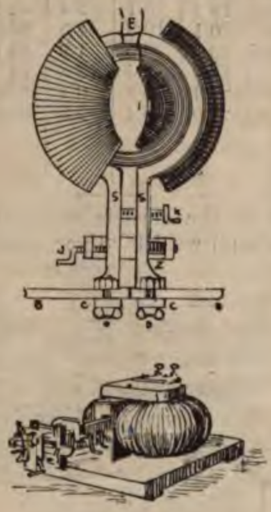


FIG. 11.

A third arrangement, and the one which is generally adopted, consists of an alternating-current dynamo giving current at, say, 300 volts; a transformer, to which the welding-table is attached; and a current regulator in the form of a choking coil which is inserted in the primary circuit between the dynamo and the transformer. Figs. 9, 10, 11, 12, and 13 show different views of these welders and of the transformers used in connection with them.

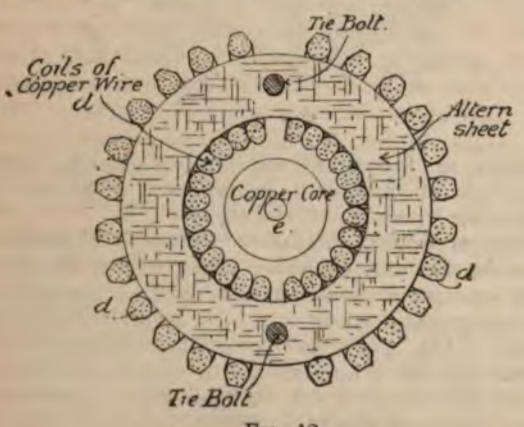


FIG. 12.

The great advantages possessed by this method of welding over every other kind are—uniform heating of the sections being welded, easy and perfect regulation of the temperature to suit various metals or alloys, absolute freedom from dirt of any kind—*e.g.*, fuel, oxides, gases, etc. Another great advantage possessed by this, as well as by the other systems of electric welding, is that it allows inspection during the process of heating.

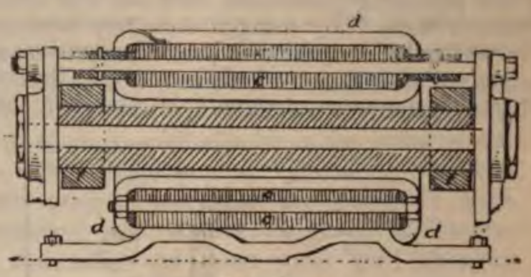


FIG. 13.

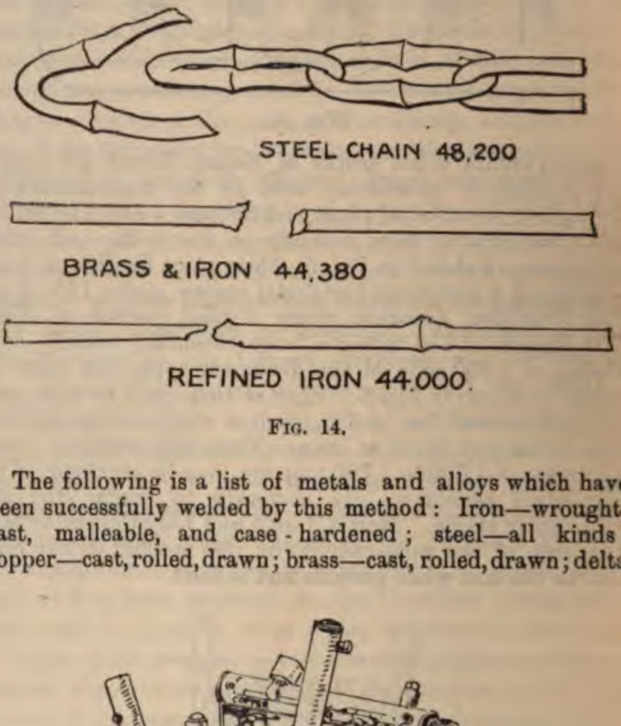


FIG. 14.

The following is a list of metals and alloys which have been successfully welded by this method: Iron—wrought, cast, malleable, and case-hardened; steel—all kinds; copper—cast, rolled, drawn; brass—cast, rolled, drawn; delta metal; aluminium; silver; gold, platinum; lead, tin, zinc, nickel, cobalt, manganese; magnesium, bismuth, iridium; bronze—aluminium, phospher, silicon, etc.; gunmetal; gold to platinum, iron to steel, brass to iron, copper to iron, bronze to iron, German silver to iron, German silver to brass, copper to brass, lead to tin, tin to zinc, brass to tin, gold to silver, silver to platinum. Broken twist drills have been mended, and tool steel forged on to common steel for turning tools, etc. A bar ⅜in. diameter has been con-

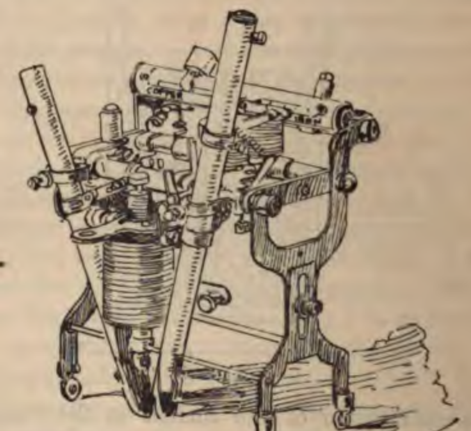
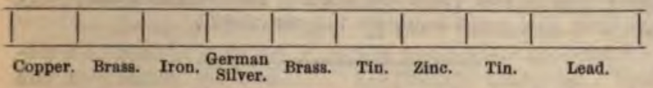


FIG. 15.

structed in this way by Prof. Elihu Thomson, as shown in sketch.



Specimens on the table show examples of this type of welding. Fig. 14 shows other examples. The cost of welding by this system is certainly less than the cost of hand welding or brazing, and the amount of work which can be turned out per man is enormously increased by it.

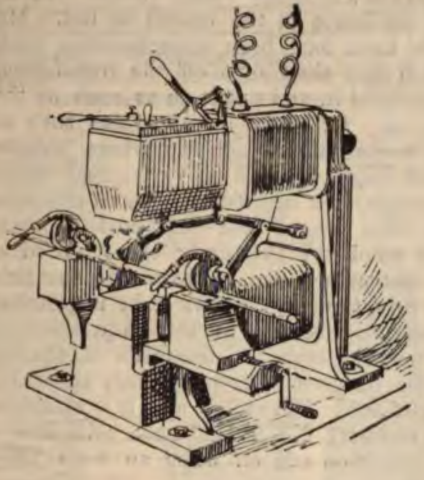


Fig. 16.

The third system patented by Coffin may be described as a combination of the other two, for the initial heating is done by forming an arc between the ends of the rods to be welded, in order to easily obtain the high resistance due to high temperature, previously explained; and when the ends have become heated in this way they are brought into contact, and a large low-pressure current sent through the junction to complete the weld.

Coffin has proposed several other methods, in one of which he interposes a thin sheet of mica partially between the ends to be welded, in order to increase the resistance locally. He also proposed, as Werdermann did in 1874 for splitting rocks, etc., to use the blowpipe action of the electric arc when under the influence of a magnet.

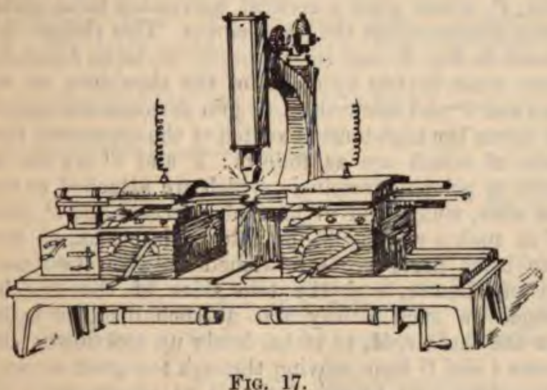


Fig. 17.

It is stated that by Coffin's method a 1in. bar can be welded with the current direct from a dynamo driven by a 1-h.p. engine. Three of Coffin's machines are illustrated in Figs. 15, 16, and 17.

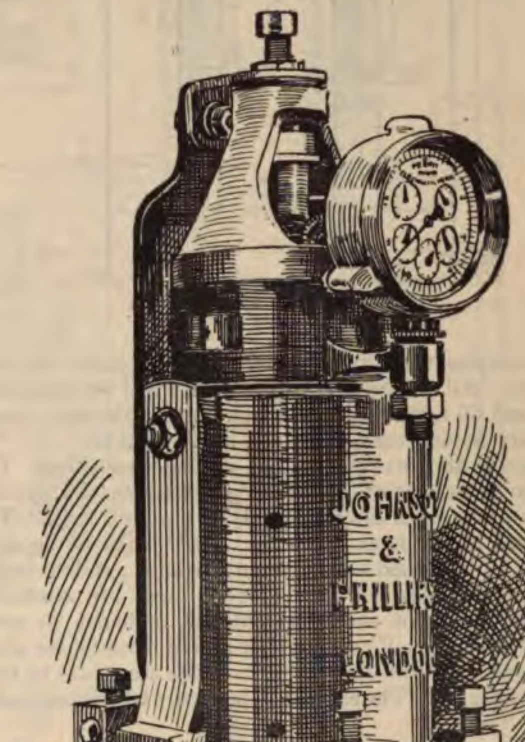
In welding by any of the above systems the fibrous state is destroyed, but can be restored by hammering in the case of iron, etc.

PROF. PERRY'S ELECTRICITY METER.

We illustrate herewith a new electricity meter invented by Prof. John Perry, F.R.S., and manufactured by Messrs. Johnson and Phillips. The meter is dependent on the well-known law of the rotation of a conductor bearing an electric current when placed in a strong magnetic field; but has certain special features which obviate the disadvantages hitherto found in meters of this type.

The magnetic field is exceedingly strong, and is formed of a number of magnets, either electromagnets or, preferably, permanent magnets, arranged in concentric manner so as to have one interior pole surrounded by an exterior concentric pole with a small interspace between. This space is filled with mercury, and in this is placed a revolving copper cup, like an inverted claret cup, of thick copper, which when the current passes revolves under the reaction upon the magnetic field. This cup, instead of being bare copper, is enamelled over all the surface, save at the bottom tip, where it is nickelled; the electric circuit is therefore extremely short, and all parts are made so that the electrical resistance is very small.

In order to obtain the desired effect that the rotation, and therefore the reading on the dials, shall be proportional to the current, it is necessary to oppose the rotation of the copper in some way. Instead of relying upon liquid friction, which, by reason of change of viscosity of liquids at varying temperature, is not constant, Prof. Perry uses the magnetic resistance of Foucault currents. As will be seen in the rough diagrams of the meter given, the magnets are not made of even surface, but are recessed in slots, so that there are points of very strong magnetic field and then points of much weaker field all the way round. The movement of any portion of the copper cup from strong to weak field generates Foucault currents, and the resistance to motion so obtained is so much stronger than the resistance by liquid friction as to render the variation in this latter practically negligible. In practice the readings by this meter are constant for all temperatures and proportional at all loads.



Perry's Electric Meter.

The moving parts are mounted on jewelled pivots, and the meter starts under the smallest current. A great advantage is that the mercury need not be specially prepared, and a little dirt or dross exerts no deleterious effect on the registration, unlike other meters, the mercury in which must be distilled and kept pure or the reading alters. There are few and simple working parts. The meter works at a slow speed and through a wide range. It is readily and easily calibrated; it may be left out of use for long periods without alteration, and needs no careful correction of errors, as the forces acting are very great, yet balanced. It needs no winding up, the action being entirely electric. There are no brushes, and no contacts other than the mercury contacts. Indeed, the only possible objection is that mercury is used; but as it is not necessary for this to be absolutely clean, and as the mercury is all boxed in, this is in reality no practical objection. There is nothing to get out of order, and the meter occupies very little space. All the parts are well insulated. All ordinary sizes of meters will be made, and the 30 and 60 ampere sizes are now being produced, special machinery having been put down by the makers.

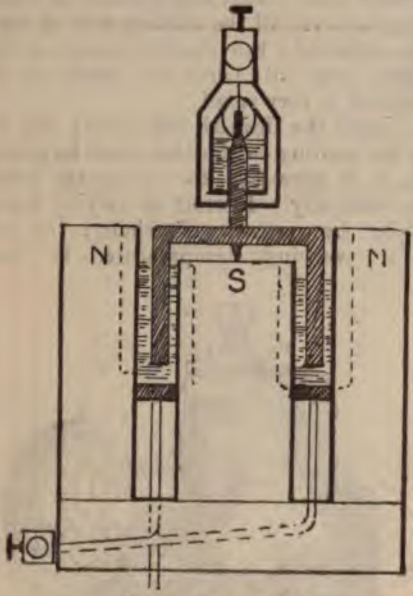
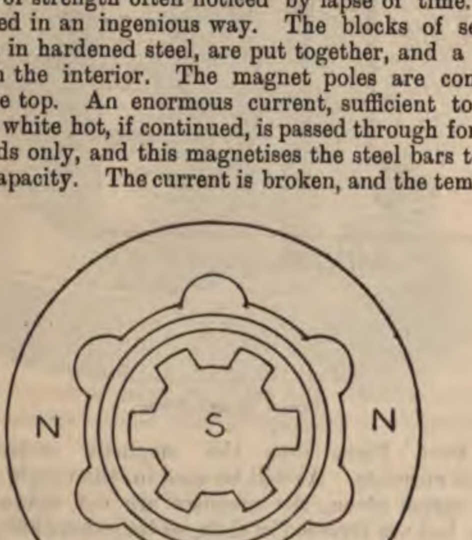


Diagram of Perry's Meter.

A word as to the magnets used will be interesting. One objection to the use of permanent magnets is the gradual decrease of strength often noticed by lapse of time. This is obviated in an ingenious way. The blocks of separate magnets, in hardened steel, are put together, and a coil is placed in the interior. The magnet poles are connected across the top. An enormous current, sufficient to make the coils white hot, if continued, is passed through for about 10 seconds only, and this magnetises the steel bars to their utmost capacity. The current is broken, and the temporary yoke is withdrawn. The magnetism then drops considerably—but then slightly increases. The permanent state so obtained has a tendency still more to slightly increase, and this balances the ordinary tendency for the magnetism to diminish by lapse of time. Magnets have been made which after five years have not shown an error of more than one-tenth of 1 per cent.



Plan of Magnets.

The meter is mounted in a strong watertight case, with plain, easily-read dials, the units being shown on a larger scale than the tens and hundreds and thousands. The contacts for the mains have had special attention paid them, so as to be easy of connection, at the same time making a good mechanical piece of work. The workmanship is of the best, and great accuracy is guaranteed.

AN AUTOMATIC SWITCH FOR TRANSFORMERS.

Discussions on transformers have during the past few years hinged on the possibility of so designing the apparatus that the loss at low load would be small. Up to the present there is a constant waste, whether the transformer secondary has lamps on the circuit or not. Messrs. New and Mayne have long been experimenting with an automatic switch that shall shut off the transformer when it has no load upon it, and put it on as soon as the smallest load comes on. Of course an apparatus such as this only stops the waste at no load, but where transformers are used in each house this will prove a great saving, and no doubt this apparatus will receive very careful attention.

In the form shown and explained a weak primary battery is employed to supply the required energy to start the instrument—*i.e.*, to switch on the primary and secondary circuits when the first light is switched on—but it is intended to substitute for this in practice a small condenser, arranged across the terminals of the high-tension switch. This, however, but very slightly alters the construction of apparatus. The switch will, it is stated, work well with two ordinary No. 2 Leclanché cells, and will automatically switch on and off when an 8-c.p. 100-volt lamp only is used.

The switch is shown in detail in Fig. 1, in which B is a brass lever, which is capable of movement from position shown to dotted position about a steel spindle, *a*. This lever, B, carries at the short but heavy end a brass taper plug, *n*, which is insulated from the lever, though capable of slight upward and downward movement, which is pressed downward into a conical seat, S and S^1, and kept tight by means of a spiral spring when the heavy end of the lever is down—*i.e.*, when the switch is "on." This brass plug, *n*, completes circuit from S to S^1 when in its seat, and thus forms the low-tension or secondary switch, as will be seen later on.

The lever, B, also carries a pin on the other side of its fulcrum, which comes into contact with an insulated spring, n^2, when the lever assumes its dotted position. At this end of lever there is, attached by a pin, an insulator connector, t^2, which gives a vertical movement to an insulator ebonite shutter when the lever moves. This shutter is seen in detail in Fig. 2, and its action is to bring *t* and t^1 into contact when it rises by means of the shoulders, m^2, which raise *t* and t^1 and allow them to join through the space, M^2. This forms the high-tension switch of the apparatus, further details of which are as follows: T and T^1 are the high-tension or primary terminals, which are attached to square brass rods, which end in movable pieces, *t* and t^1, pivoted at t^3 in such a way as to be able to interlock, as shown. These brass parts are sandwiched between two parallel slabs of ebonite, and the two sides of the switch are arranged in such a way and at such distance apart to allow the shutter, M, to travel freely up and down. Stops prevent *t* and t^1 from moving through too great an angle.

Connected also to this lever, B, as shown, is a spiral steel spring, Q, whose other end is attached to a laminated iron core, P (which is preferably made taper as shown), which slides freely in a solenoid (also wound taper), R^1. Connected by a chair or cord, *b*, over pulleys, b^1 to P^1, is another similar core, P^2, which is so constructed as to be held by the catch, *m*. This cord, *b*, passes through the centre of a circular brass plate, b^2, which carries four conical plugs, C, C^1, C^2, and C^3, by means of loose pins, with heads as shown. These loose pins are of such lengths that C is shorter than C^1 by a fraction—say, $\frac{1}{16}$th—C^1 than C^2, and C^2 than C^3. The result of this is that when P^1 raises b^2, then one plug after the other becomes raised. Attached to the top of R^1 are four brass divided seatings, into which the four brass plugs fall and fit when P^1 no longer supports b^2. These seatings are so arranged and divided that when the plugs are down a through electrical connection is established between the first and last brass piece. When, however, plug C is raised, the resistance d, which is connected as shown in Fig. 3, becomes placed in this circuit. When C^1 is raised, d^2 is in circuit; when C^2 is raised d^3 is also in circuit, and when C^3 is raised circuit is broken. This reduces sparking. The core P^2 travels in the solenoid R^2, when core P^1 travels in the solenoid R^1. K is a spiral spring attached to P^1, to reduce the shock of B rising, and also to tend to start P^2 upward.

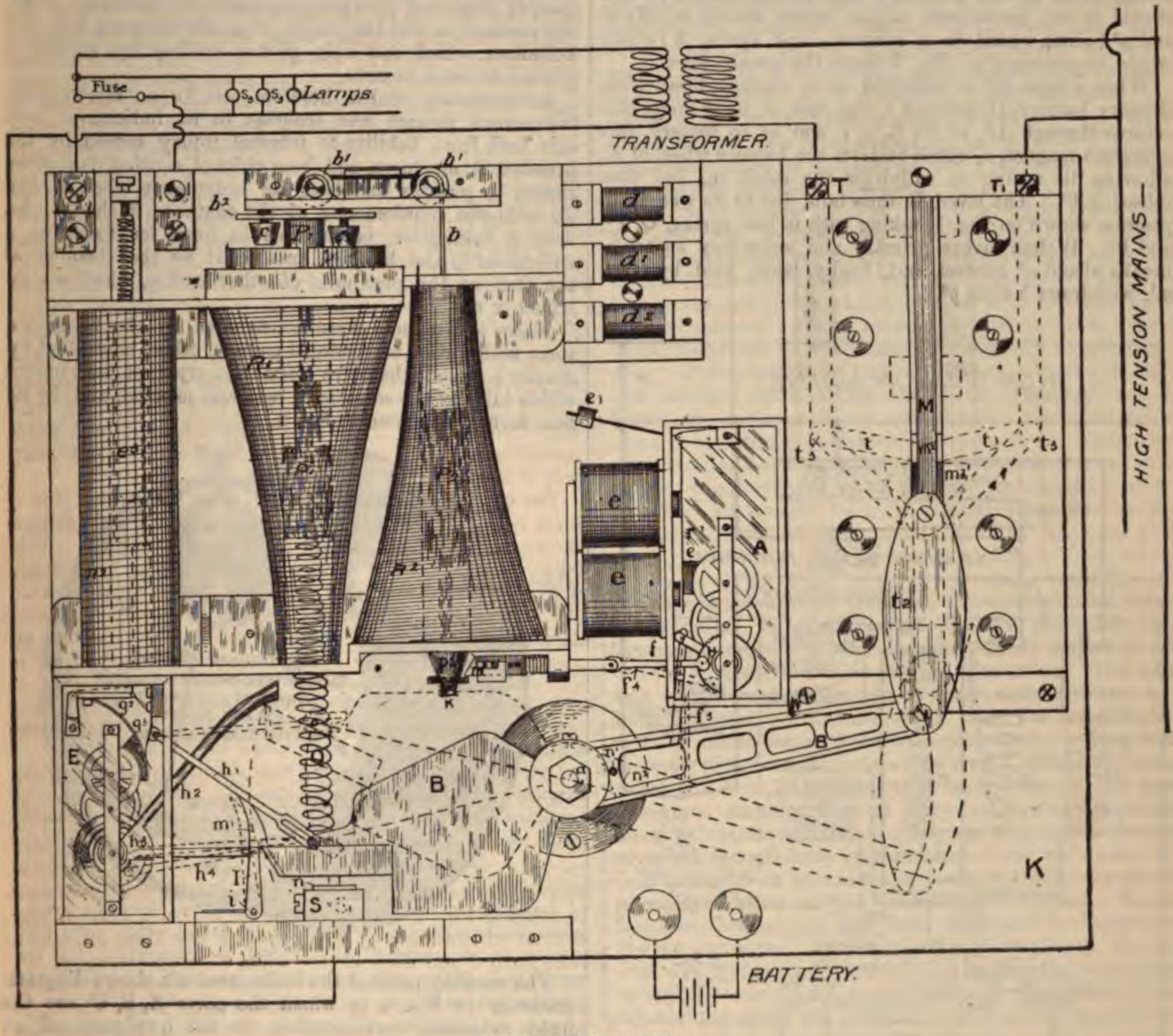


FIG. 1.—Details of Switch.

A is a train of clockwork having a large and heavy balance wheel, and r is an ordinary horseshoe electromagnet, wound with many turns of fine wire, which when excited withdraws a brake, e, by means of a balanced armature, r^1, from said balance wheel, the adjustable weight, e^1, tending to press it, e, against the balance wheel. The slowest running wheel of this train, A, is firmly connected to two arms, f and f^1, which are set at an angle of 45deg. to each other; the arm f has a link, f^3, pinned to it, which is so arranged as to be lifted by the lever, B, rising from dotted position, a spring compression being interposed to prevent too sudden a movement of f; the arm f^1 is connected by a link to the catch, m, in such a way that when f is at the top position m is in a catching position, and when f is at bottom position m is withdrawn. This wheel with arms, f and f^1, is able to revolve through an angle of 90deg. The catch, m, is so arranged that P^2 can always pass it downwards only. Attached also to these arms, f and f^1, with wheel centre is a steel main spring, whose other end is securely fixed to framework of train, in such a way as to tend to bring f downwards about its centre. E is a second train of clockwork wheels, with a heavy balance wheel, against which a steel spring, h, tends to press. Connected to h by a pin is a link, h^1, which has a slot at its further end, in which works a pin attached to lever, B. This pin and link h^1 is so arranged that the spring, h, presses the brake, g^3, against the balance wheel, except when the lever, B, is "on"—*i.e.*, in position shown.

This train of wheels, E, is so arranged that when the lever, B, rises to dotted position it carries the arm h^2 up with it to position shown, Fig. 1, thus winding up a main spring, but, owing to a ratchet wheel and pawl, not moving the train of wheels round; attached to this arm h^2, at an angle, as shown, is a second short arm, h^3, which by means of link h^4, in moving from horizontal to vertical, withdraws a catch, I and m^1, which catch holds the lever in its bottom position as shown. This catch, m^1, is so arranged as always to allow lever to pass it downwards only.

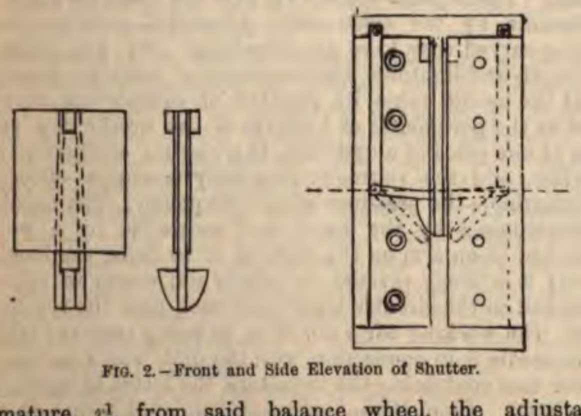


FIG. 2.—Front and Side Elevation of Shutter.

R^2 is a solenoid of few turns of stout copper wire, R.C.C., which when a small current passes through it draws down a soft iron tube or core, r^3, which is held by the spring, g, and regulating screw, g^1, which is rigidly connected to a pivoted arm, g^2. This arm, g^2, has attached to it the brake, g^3, and it will be seen that depressing r^3 will apply the brake, g^3, to the balance wheel of E.

Having now described the various parts of the instrument, we will consider a full cycle of its action :

Fig. 1 shows the positions of all parts, except lever (which should be in dotted position), high-tension switch (which should be off), low-tension switch (which should be off), n^1 and n^2 (which would be in contact), and spring h (which would be passing g^3). Fig. 3 shows the connections.

When a light, S^3, is switched on, a current flows from primary battery, D, through L and fuse, Z, to S^3 lamp, and returns through L^2, r^2, S^1, R, n, r, and n^1 to battery, this energised magnet, r, which releases the balance wheel of A, allowing its spring to withdraw the catch, m, and thus releasing P^2. The lever, B, then falls, due to its weight, to position shown on Fig. 1, taking with it the spring, Q, P^1, and P^2. It thus makes primary and secondary switches, breaks n^1 and n^2 contact, and, finally, when held by catch m^1, withdraws h from g^3.

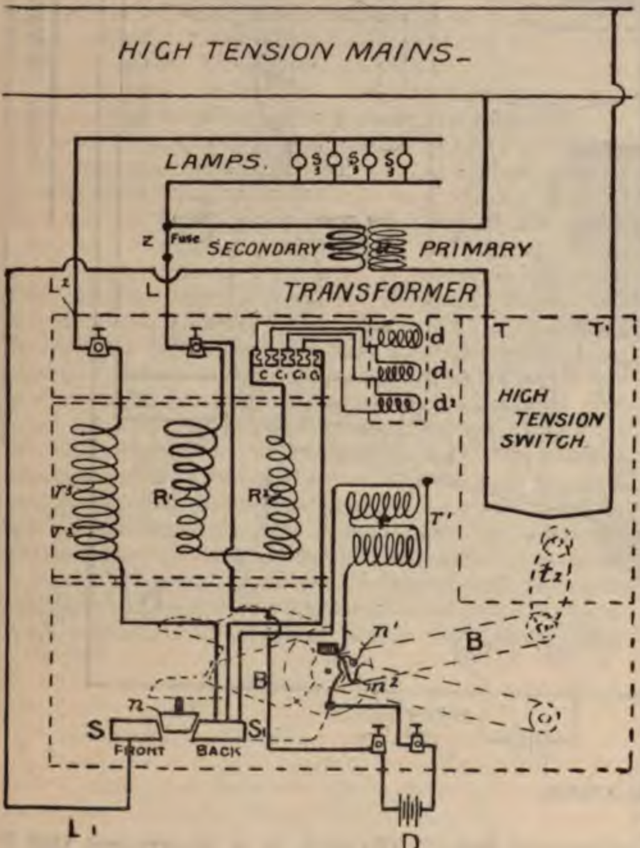


FIG. 3.—Connections.

It will then be seen that the primary circuit to transformer is complete, that the secondary circuit of transformer through L^1, S, S^1, r^3, and lamps, S^3, is made, and that a second circuit in series with the latter is also made through L^1, S, S^1, C^3, C^2, C^1, C, R^2, R^1, L, and fuse Z. This last current circuit energises R^1 and R^2 in such a way that their cores are driven back to original positions—those shown, where catch m again holds P^2; as A has been reset by lever, B, raising f^3 and P^1 raises b^2, breaking sparklessly this actuating circuit. The spring, Q_1, is now attempting to lift lever, B, to its dotted position, but cannot do so owing to the catch m_1 holding it.

When now the last light, S^3, is switched off current ceases to flow through r^2, and consequently, as r^3 is released, g^2 rises with r^3, withdrawing the brake, g^3, from clockwork, E. The spring of E then moves the train, E, and in so doing m^1 is withdrawn, releasing B, which assumes the dotted position once more. The lever, B, in rising rewinds clockwork, E, by means of arm h^2, and also resets mechanism for another *cycle of* actions.

AYRTON AND MATHER'S ELECTROSTATIC VOLTMETER.

For the last three or four years Prof. Ayrton, in conjunction with Mr. Mather, has been experimenting with a view to the construction of a trustworthy and accurate electrostatic voltmeter for the measurement of high pressure. There can be no question about the great advantage of placing an electrostatic voltmeter direct on the high-pressure mains, over the clumsy expedient frequently employed of wasting power in transforming down the pressure to suit the range of a low-pressure hot-wire voltmeter, which can only give a reading by wasting a great deal more power.

An increasing need is therefore felt for an electrostatic instrument prompt and accurate in its indications, and safe both from liability to internal injury caused by the pressure it measures, and from risks of causing dangerous shocks to persons handling the instrument when in use. To fulfil the requirements of the engineer, it should also have a bold scale, be suitable in form for fixing on a switchboard, and be quite unaffected by the cleaning of the glass or the proximity of other bodies, whether electrified or not.

Many instruments were constructed by the inventors, some with spring or torsional control, others controlled by gravity; after exhaustive tests the style of instrument which fulfilled the conditions best was selected, and in its final form it is shown in Fig. 1.

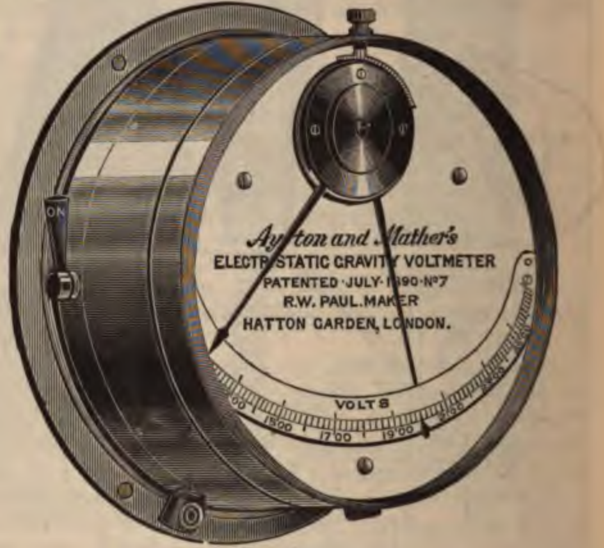


FIG. 1.

The working parts of the instrument are shown diagrammatically in Fig. 2, in which the parts A, B, C are the fixed inductors, corresponding to the quadrants of an electrometer. These inductors are curved brass plates, whose edges and corners are carefully rounded to prevent sparking. They are connected together by the plate D, and fixed in an inner case, from which they are highly insulated. The "needle," E F, consists of two thin curved aluminium plates concentric with the staff, G, which carries them. These plates are drawn into the space between the inductors by the electrostatic attraction between them. Being curved they have the advantage over flat plates in strength and lightness, their moment of inertia is small, so that the needle takes its position of equilibrium rapidly, and as the peripheries and spokes of the needle are made out of one piece of aluminium, the electric conductivity is perfect, and the voltmeter accurately measures—direct or alternating—the pressures of any frequency. The needle is counterpoised by the hand, and controlled by a weight attached to an arm on the staff, so as to bring the hand to zero; it is finely pivoted in jewels and works in a frame attached to the circular brass plate seen near the top of the dial. The working parts can thus be easily removed bodily. The needle is in connection with the dial, which carries the inner case containing the inductors, the latter being highly insulated. From the inductors an insulated spring reaches downwards alongside a similar spring attached to the inner case; these springs make contact with the terminals.

The dial is supported on ebonite pillars and surrounded by a bezel ring of ebonite which prevents contact with the outer case; the latter is therefore entirely insulated from the circuit.

Each terminal, of which a section is shown in Fig. 3, is cased in ebonite, so that a person connecting up cannot receive shock from it. The hollow ebonite portion, A A, contains a brass block, E, embedded near its outer end and covered by an ebonite nipple; the block is tapped for the set-screw, F, which holds the wire in place. The part of A which projects into the case, into which it screws at B, contains a fuse of platinum-silver ·001in. diameter, enclosed in a glass tube with metal caps to which it is connected. They make contact with the block, E, at one end and the spring cap, D, at the other. The cap, D, makes contact in turn with the connecting spring mentioned above. The fuses are, therefore, very easily replaced.

To enable the instrument to be easily disconnected from the mains when necessary, a switch is provided; the handle seen on the left side of the instrument is attached to a cam-shaft, and turning it down raises the springs from the caps, D, of the terminals, and so disconnects the instrument from the mains; it then short-circuits the inductors and needle, bringing them to the same potential.

A spark gap is arranged inside the voltmeter; before the instrument is sent out it is tested at considerably above the working pressure for sparking between the needle and inductors, the gap is then adjusted, so that in case of abnormal rise of pressure sparking will occur at the gap and produce no damage.

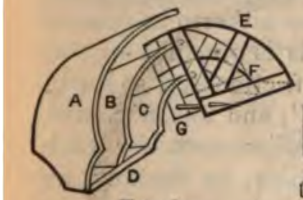


FIG. 2.

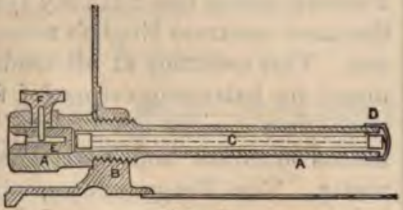


FIG. 3.

A device is provided whereby the engineer may see at a glance whether the working pressure is being maintained; it consists of an index below the scale (seen to the right of Fig. 1), adjustable by a crown wheel and pinion at the top of the instrument. It can be thus seen at a distance whether the pressure is right—that is, whether the hand and index coincide. When the index is turned as far as it will go to the left, it clamps the needle for travelling.

The scale has a radius of 6in. and a length of 10in., thus giving a bold open scale whose clearness is enhanced by the dead-white silver of the dial. The external diameter of the instrument is 12in. The instruments at present made are suitable for circuits at 500, 1,000, 2,000, and 2,400 volts, the range being very open near the working pressure. By differently shaping the inductors an equally-divided scale may be obtained when desired. The instruments are made by Mr. Paul, of Hatton-garden.

REVIEWS.

Electric Lighting and Power Distribution. Part II. By W. PERREN MAYCOCK, M.I.M.E. With 85 illustrations. Price 2s. 6d. Whittaker and Co.

The student of dynamo construction requires a certain well-defined psychological process to be followed in instructing him. The teacher, as a rule, being himself in the possession of the information from experience, but usually having forgotten his own desires when learning, does not and often cannot quite put himself in the position of the enquirer, to see what are the things the learner wants to know first, and in what order does he want to know them. The process, we imagine, should be somewhat of this kind: First, to point out a typical machine of the most usual kind; show experimentally what it can do; then on what principles its action is based, with experiments to prove these principles; after this, an analysis piece by piece showing where the mind of man has modified here, inserted dodges there, built up in this manner and simplified in this or that way—all for a required result to be obtained—a result that may be different for different purposes. For dynamos, these are—Direct current: (*a*) constant potential and varying current; (*b*) rise of potential to compensate for increase of load; (*c*) constant current and varying pressure. For alternate current: (*d*) high potential for transforming down; and (*e*) low potential for transforming up—at various periodicities of alternation. Separating out the simplest form of direct-current machine, examples can be given of several of the best-known makes, generalising to show that, different as they look, the same elementary principles run through all, modified by considerations of (*a*) material used, (*b*) cheapness of construction, (*c*) space to be taken up, (*d*) speed and facility of driving, etc. Having obtained the general outlook, a special example of a perfectly usual kind should be taken, and the method of "calculating" and designing this dynamo should be given, in detail, explaining the various difficulties as they arise, reducing the question of designing a machine to its simplest essence: (*a*) direct, (*b*) alternate-current machines for working at, say, 100 volts. Being then in the position to know what the various manufacturers were driving at in making their different machines, these machines themselves might be now illustrated, analysed, calculated afresh, with full interest and appreciation on the part of the student—who, it is to be feared, would only be puzzled by the number of variations in type if given, simply as so many examples to study, at the beginning. The questions of magnetic circuit, winding, E.M.F., and current, characteristic curves, the efficiency, and so forth—the main problems of dynamo construction—all come in a perfectly predetermined order to the designer of dynamos; and the explanations of them should come in an equally predetermined order for the consideration of the student. In the book before us we cannot perceive that this attitude of mind on the part of the pupil has been sufficiently considered. It is true we have a fine set of examples of the usual types of dynamos; but more as a list than as an ordered grouping, illustrating principles of construction. For instance, the essential principles regulating construction of alternators are hardly made to stand out for all types in the chapter on alternators. The question of characteristic curves is dealt with, but it would have been easy for the need which called for these curves, and the usefulness of them in actual work, to have been more forcibly brought before the view. Efficiency, again, dismissed here in a paragraph, being one of the most important considerations of dynamo construction, might have been treated in full, showing actual practical methods of taking the efficiency of machines.

The chapter on incandescent lamps is sufficiently clearly given, and furnishes the information required. The arc lamp, however, might have been illustrated in diagram for the various types. The descriptions of the Brush, Brockie-Pell, and Midget lamps are full, but might have been edited to appeal to the intelligence of a person presumably knowing nothing about the question. As it is, the descriptions are accurate, but too much like those in a patent specification or in a trade circular, where readers are supposed to be technically cognisant of the principles and even the details of various types. The dynamo illustrations are too often merely perspective views—pretty, but not so instructive to embryo engineers as working drawings and diagrams; some of the latter are given, but for the least-known makes of machine.

The questions added to the chapters are here for the most part sufficiently practical, though there might easily be inserted others even more necessary: for instance, as to considerations for designing dynamos for special circumstances; density of current; rise of temperature; how to test for efficiency; the necessity, or otherwise, of having resistances for working arc lamps, alternate-current arc lamps, and so forth, met with constantly in actual work. The book is well printed, and the illustrations well and clearly drawn. Part III. of the work is promised shortly, and deals with accumulators, transformers, central stations, switches, and measurement. Although not to be considered yet as an ideal introductory text-book, it contains the material for a useful introduction to electrical engineering. It is probable there will be a good sale, and in a further edition a complete overhaul, like that given by Prof. Thompson to his more advanced work, would place Mr. Maycock's text-book in an extremely useful position.

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METERS.

Where is the perfect electric meter ? is a question asked of electric supply companies by private customers, of manufacturers by the companies, and of inventors by the manufacturers. We have seen some sufficiently good meters selling well on the market—from Germany, the Aron ; from France, Frager and Brillé ; from America, Shallenberger and Thomson. In England, of those which have promised well there are the Ferranti and the Teague meters. The Shallenberger has sold, we are told, at the rate of 4,000 a year : Ferranti probably sells more, for this figure is not large when we consider that every purchaser will be bound by law to have an electric meter on the premises. We have heard good things of the Schuckert meter now largely used in Germany, and there are also Edmondson's, Hookham's, and the new Reckenzaun meter and others, all bidding for popularity. We are able to illustrate and describe this week a new meter, invented by Prof. Perry, which has a very fair future before it. It will be interesting to compare it with two of its present rivals — the Ferranti meter and the Teague meter. The Ferranti meter has certainly the reputation of being the most accurate English meter hitherto in general use. This accuracy at all loads is obtained in this meter by balancing errors (of friction and so forth) to obtain a straight line "curve"; and this, of course, means accurate and special adjustment for each meter. The Teague meter, which, by the way, we believe was the only one definitely passed by the Board of Trade, has turned out to possess qualities the reverse of satisfactory. Prof. Perry himself pointed out some time ago to the authorities that from the construction there would be a large error from change of temperature, due to a physical law too apt to be overlooked—namely, the change in viscosity of liquids at alteration of temperature. The resistance to increase of motion in a cup revolving in liquid when large current passes is obtained in this class of meter by liquid friction. Now, the viscosity of all liquids—glycerine and water, and mercury, as well as other liquids—changes greatly by reason of change of temperature, so that a large error creeps in. Such liquids change as much as 30 per cent. from summer to winter, and some liquids change even as much as 2,000 per cent. The resistance to motion, therefore, cannot here be constant, a fact which has led to unsatisfactory registration. In Prof. Perry's meter this effect is rendered negligible by the superposition to the liquid friction (which is made as small as possible) of electromagnetic friction by means of Foucault currents generated in the revolving copper cup. The magnet poles between which the copper revolves, instead of being symmetrical, and the field even, are made toothed, and the field is therefore in parts very strong and then much weaker alternately. The rotation of the copper from strong to weak field generates considerable eddy currents, and it is the electromagnetic friction so produced—some thirty times greater than the liquid friction—which opposes the rotation of the copper cup, and renders the readings proportional to the current at no matter what temperature. The adoption of this ingenious expedient, due entirely to Prof. Perry, seems to afford a satisfactory solution of the difficulty, at the same time enabling the mechanism to be of great simplicity. The meter question is one of enormous importance to the industry, and if Prof. Perry has satisfactorily solved it he must be heartily congratulated, but in meters, as in other things, time and trial are the only proofs that can be accepted as final.

CORK TRAMWAYS.

The town of Cork is so desirous of having electric traction, that a deputation waited upon the Corporation at the last meeting to ask that the proposed tramway should be worked by electricity. The example of Leeds and Birmingham was cited, and the fact that Bristol and Edinburgh were about to adopt it mentioned. The Corporation, it appears, have already sanctioned electricity, provided it could be supplied underground, but the promoters say this is as yet impossible. Mr. S. Frazer, C.E., argued fully for the scheme, and said, though at first more expensive, in the end it must be a success. In order to fully discuss the boon to the citizens of Cork, the scheme was referred to the city engineer to report.

ON LIGHT AND OTHER HIGH - FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

INTRODUCTORY.—SOME THOUGHTS ON THE EYE.

When we look at the world around us, on Nature, we are impressed with its beauty and grandeur. Each thing we perceive, though it may be vanishingly small, is in itself a world—that is, like the whole of the visible universe, matter and force governed by law—a world, the contemplation of which fills us with feelings of wonder and irresistibly urges us to ceaseless thought and enquiry. But in all this vast world, of all objects our senses reveal to us, the most marvellous, the most appealing to our imagination, appears, no doubt, a highly developed organism, a thinking being. If there is anything fitted to make us admire Nature's handiwork, it is certainly this inconceivable structure, which performs its innumerable motions in obedience to external influence. To understand its workings, to get a deeper insight into this Nature's masterpiece, has ever been for thinkers a fascinating aim, and after many centuries of arduous research men have arrived at a fair understanding of the functions of its organs and senses. Again, in all the perfect harmony of its parts, of the parts which constitute the material or tangible of our being, of all its organs and senses, the eye is the most wonderful. It is the most precious, the most indispensable of our receptive or directive organs, it is the great gateway through which all knowledge enters the mind. Of all our organs, it is the one which is in the most intimate relation with that which we call intellect. So intimate is this relation that it is often said that the very soul shows itself in the eye.

It can be taken as a fact, which the theory of the action of the eye implies, that for each external impression—that is, for each image produced upon the retina—the ends of the visual nerves, concerned in the conveyance of the impression to the mind, must be under a peculiar stress or in a vibratory state. It now does not seem improbable that, when by the power of thought an image is evoked, a distinct reflex action, no matter how weak, is exerted upon certain ends of the visual nerves, and, therefore, upon the retina. Will it ever be within human power to analyse the condition of the retina when disturbed by thought or reflex action, by the help of some optical or other means of such sensitiveness, that a clear idea of its state might be gained at any time? If this were possible, then the problem of reading one's thoughts with precision, like the characters of an open book, might be much easier to solve than many problems belonging to the domain of positive physical science in the solution of which many, if not the majority, of scientific men implicitly believe. Helmholtz has shown that the fundi of the eyes are themselves luminous, and he was able to see, in total darkness, the movement of his arm by the light of his own eyes. This is one of the most remarkable experiments recorded in the history of science, and probably only a few men could satisfactorily repeat it, for it is very likely that the luminosity of the eyes is associated with uncommon activity of the brain and great imaginative power. It is fluorescence of brain action, as it were.

Another fact having a bearing on this subject which has probably been noted by many, since it is stated in popular expressions, but which I cannot recollect to have found chronicled as a positive result of observation, is that at times, when a sudden idea or image presents itself to the intellect, there is a distinct and sometimes painful sensation of luminosity produced in the eye, observable even in broad daylight.

The saying, then, that the soul shows itself in the eye is deeply founded, and we feel that it expresses a great truth. It has a profound meaning even for one who, like a poet or artist, only following his inborn instinct or love for Nature, finds delight in aimless thoughts, and in the mere contemplation of natural phenomena, but a still more profound meaning for one who in the spirit of positive scientific investigation seeks to ascertain the causes of the effects. It is principally the natural philosopher, the physicist, for whom the eye is the subject of the most intense admiration.

Two facts about the eye must forcibly impress the mind of the physicist, notwithstanding he may think or say that it is an imperfect optical instrument, forgetting that the very conception of that which is perfect, or seems so to him, has been gained through this same instrument. Firstly, the eye is, as far as our positive knowledge goes, the only organ which is directly affected by that subtle medium, which, as science teaches us, must fill all space; secondly, it is the most sensitive of our organs, incomparably more sensitive to external impressions than any other.

The organ of hearing implies the impact of ponderable bodies, the organ of smell the transference of detached material particles, and the organs of taste, and of touch or force, the direct contact, or at least some interference of ponderable matter, and this is true even in those instances of animal organisms in which some of these organs are developed to a degree of truly marvellous perfection. This being so, it seems wonderful that the organ of sight solely should be capable of being stirred by that which all our other organs are powerless to detect, which yet plays an essential part in all natural phenomena, which transmits all energy and sustains all motion and, that most intricate of all, life, but which has properties such that even a scientifically-trained mind cannot help drawing a distinction between it and all that is called matter. Considering merely this, and the fact that the eye, by its marvellous power, widens our otherwise very narrow range of perception far beyond the limits of the small world which is our own, to embrace myriads of other worlds, suns, and stars in the infinite depths of the universe, would make it justifiable to assert that it is an organ of a higher order. Its performances are beyond comprehension. Nature, as far as we know, never produced anything more wonderful. We can get barely a faint idea of its prodigious power by analysing what it does and by comparing. When ether waves impinge upon the human body, they produce the sensations of warmth or cold, pleasure or pain, or perhaps other sensations of which we are not aware, and any degree or intensity of these sensations, which degrees are infinite in number, hence an infinite number of distinct sensations. But our sense of touch, or our sense of force, cannot reveal to us these differences in degree or intensity, unless they are very great. Now we can readily conceive how an organism, such as the human in the eternal process of evolution, or more philosophically speaking, adaptation to Nature, being constrained to the use of only the sense of touch or force, for instance, might develop this sense to such a degree of sensitiveness or perfection that it would be capable of distinguishing the minutest differences in the temperature of a body, even at some distance, to a hundredth, or thousandth, or millionth part of a degree. Yet even this apparently impossible performance would not begin to compare with that of the eye, which is capable of distinguishing and conveying to the mind in a single instant innumerable peculiarities of the body, be it in form or colour or other respects. This power of the eye rests upon two things—namely, the rectilinear propagation of the disturbance by which it is affected, and upon its sensitiveness. To say that the eye is sensitive is not saying anything. Compared with it, all other organs are monstrously crude. The organ of smell which guides a dog on the trail of a deer, the organ of touch or force which guides an insect in its wanderings, the organ of hearing, which is affected by the slightest disturbances of the air, are sensitive organs, to be sure, but what are they compared with the human eye! No doubt it responds to the faintest echoes or reverberations of the medium; no doubt it brings us tidings from other worlds, infinitely remote, but in a language we cannot as yet always understand. And why not? Because we live in a medium filled with air and other gases, vapours and a dense mass of solid particles flying about. These play an important part in many phenomena; they fritter away the energy of the vibrations before they can reach the eye; they, too, are the carriers of germs of destruction, they get into our lungs and other organs, clog up the channels and imperceptibly, yet inevitably, arrest the stream of life. Could we but do away with all ponderable matter in the line of sight of the telescope, it would reveal to us undreamt-of marvels. Even the unaided eye, I think, would be capable of distinguishing, in the pure medium, small objects at distances measured probably by hundreds, or perhaps thousands, of miles.

But there is something else about the eye which impresses us still more than these wonderful features which we observe, viewing it from the standpoint of a physicist, merely as an optical instrument—something which appeals to us more than its marvellous faculty of being directly affected by the vibrations of the medium, without interference of gross matter, and more than its inconceivable sensitiveness and discerning power. It is its significance in the processes of life. No matter what one's views on Nature and life may be, he must stand amazed when for the first time in his thoughts he realises the importance of the eye in the physical processes and mental performances of the human organism. And how could it be otherwise, when he realises that the eye is the means through which the human race has acquired the entire knowledge it possesses, that it controls all our motions, more still, all our actions.

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* A lecture delivered before the Franklin Institute, at Philadelphia, February 24, 1893; and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

There is no way of acquiring knowledge except through the eye. What is the foundation of all philosophical systems of ancient and modern times; in fact, of all the philosophy of man? I am, I think; I think, therefore I am. But how could I think, and how would I know that I exist if I had not the eye? For knowledge involves consciousness; consciouness involves ideas, conceptions; conceptions involve pictures or images, and images the sense of vision, and therefore the organ of sight. But how about blind men, will be asked? Yes, a blind man may depict in magnificent poems forms and scenes from real life, from a world he physically does not see. A blind man may touch the keys of an instrument with unerring precision, may build the fastest boat, may discover and invent, calculate and construct, may do still greater wonders—but all the blind men who have done such things have descended from those who had seeing eyes. Nature may reach the same result in many ways. Like a wave in the physical world, in the infinite ocean of the medium which pervades all, so in the world of organisms, in life, an impulse started proceeds onward, at times, may be, with the speed of light, at times, again, so slowly that for ages and ages it seems to stay, passing through processes of a complexity inconceivable to men, but in all its forms, in all its stages, its energy ever and ever integrally present. A single ray of light from a distant star falling upon the eye of a tyrant in bygone times may have altered the course of his life, may have changed the destiny of nations, may have transformed the surface of the globe, so intricate, so inconceivably complex are the processes in Nature. In no way can we get such an overwhelming idea of the grandeur of Nature than when we consider, that in accordance with the law of the conservation of energy, throughout the Infinite, the forces are in a perfect balance, and hence the energy of a single thought may determine the motion of a universe. It is not necessary that every individual, not even that every generation or many generations, should have the physical instrument of sight in order to be able to form images and to think—that is, form ideas or conceptions; but some time or other during the process of evolution the eye certainly must have existed, else thought, as we understand it, would be impossible, else conceptions, like spirit, intellect, mind, call it as you may, could not exist. It is conceivable that in some other world, in some other beings, the eye is replaced by a different organ, equally or more perfect, but these beings cannot be men.

Now, what prompts us to all voluntary motions and actions of any kind? Again the eye. If I am conscious of the motion, I must have an idea or conception—that is, an image—therefore the eye. If I am not precisely conscious of the motion, it is because the images are vague or indistinct, being blurred by the superimposition of many. But when I perform the motion, does the impulse which prompts me to the action come from within or from without? The greatest physicists have not disdained to endeavour to answer this and similar questions and have at times abandoned themselves to the delights of pure and unrestrained thought. Such questions are generally considered not to belong to the realm of positive physical science, but will before long be annexed to its domain. Helmholtz has probably thought more on life than any modern scientist. Lord Kelvin expressed his belief that life's process is electrical, and that there is a force inherent to the organism and determining its motions. Just as much as I am convinced of any physical truth I am convinced that the motive impulse must come from the outside. For consider the lowest organism we know—and there are probably many lower ones—an aggregation of a few cells only. If it is capable of voluntary motion it can perform an infinite number of motions, all definite and precise. But now a mechanism consisting of a finite number of parts, and few at that, cannot perform an infinite number of definite motions, hence the impulses which govern its movements must come from the environment. So, the atom, the ulterior element of the universe's structure, is tossed about in space eternally, a play to external influences, like a float in a troubled sea. Were it to stop its motion it would die. Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered. This is the way in which Prot. Dewar forcibly expresses it in the description of his admirable experiments, in which liquid oxygen is handled as one handles water, and air at ordinary pressure is made to condense and even to solidify by the intense cold. Experiments which serve to illustrate in his language the last feeble manifestations of life, the last quiverings of matter about to die. But human eyes shall not witness such death. There is no death of matter, for throughout the infinite universe all has to move, to vibrate—that is, to live.

I have made the preceding statements at the peril of treading upon metaphysical ground in my desire to introduce the subject of this lecture in a manner not altogether uninteresting, I may hope, to an audience such as I have the honour to address. But now then, returning to the subject, this divine organ of sight, this indispensable instrument for thought and all intellectual enjoyment which lays open to us the marvels of this universe, through which we have acquired what knowledge we possess, and which prompts us to and controls all our physical and mental activity, by what is it affected? By light! What is light?

We have witnessed the great strides which have been made in all departments of science in recent years. So great have been the advances that we cannot refrain from asking ourselves, Is this all true, or is it but a dream? Centuries ago men have lived, have thought, discovered, invented, and have believed that they were soaring, while they were merely proceeding at a snail's pace. So we too may be mistaken. But taking the truth of the observed events as one of the implied facts of science, we must rejoice in the immense progress already made, and still more in the anticipation of what must come, judging from the possibilities opened up by modern research. There is, however, an advance which we have been witnessing, which must be particularly gratifying to every lover of progress. It is not a discovery, or an invention, or an achievement in any particular direction. It is an advance in all directions of scientific thought and experiment. I mean the generalisation of the natural forces and phenomena, the looming up of a certain broad idea on the scientific horizon. It is this idea which has, however, long ago taken possession of the most advanced minds, to which I desire to call your attention, and which I intend to illustrate, in a general way, in these experiments, as the first step in answering the question "What is light?" and to realise the modern meaning of this word.

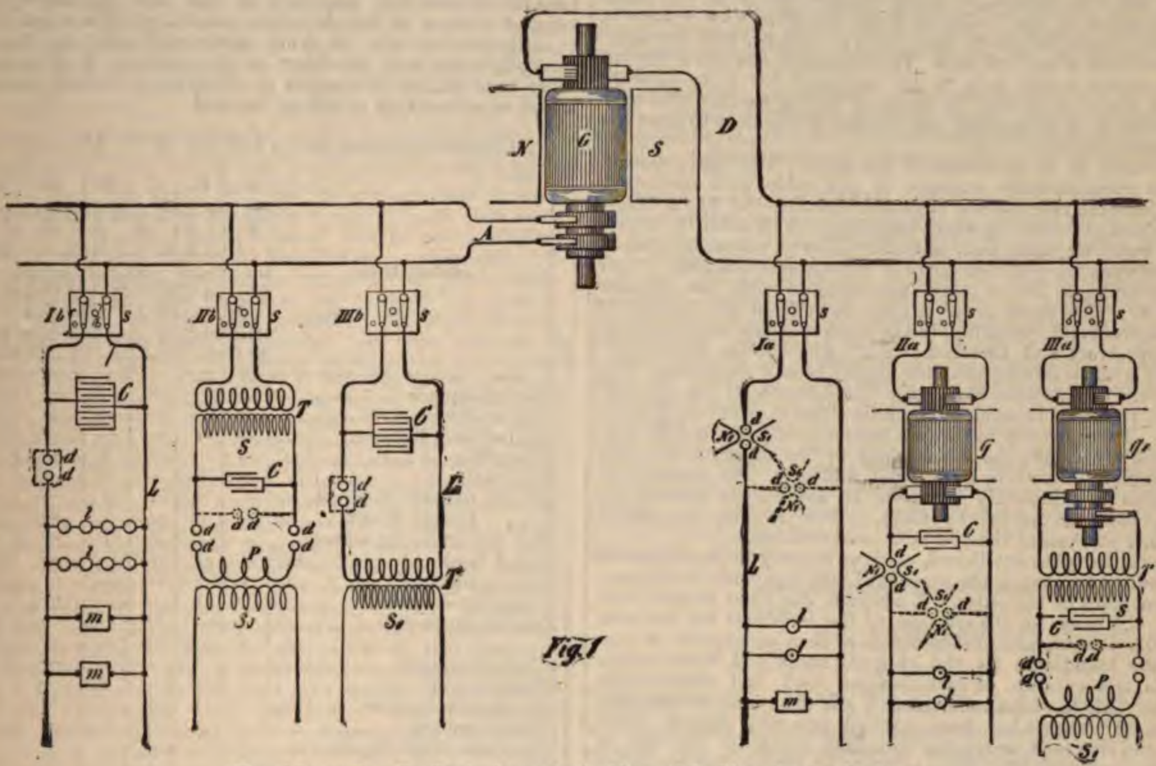
It is beyond the scope of my lecture to dwell upon the subject of light in general, my object being merely to bring presently to your notice a certain class of light effects and a number of phenomena observed in pursuing the study of these effects. But to be consistent in my remarks it is necessary to state that according to that idea, now accepted by the majority of scientific men as a positive result of theoretical and experimental investigation, the various forms or manifestations of energy which were generally designated as "electric," or, more precisely, "electromagnetic," are energy manifestations of the same nature as those of radiant heat and light. Therefore the phenomena of light and heat, and others besides these, may be called electrical phenomena. Thus electrical science has become the mother science of all, and its study has become all-important. The day when we shall know exactly what "electricity" is will chronicle an event probably greater, more important than any other recorded in the history of the human race. The time will come when the comfort, the very existence, perhaps, of man will depend upon that wonderful agent. For our existence and comfort we require heat, light, and mechanical power. How do we now get all these? We get them from fuel, we get them by consuming material. What will man do when the forests disappear, when the coalfields are exhausted? Only one thing, according to our present knowledge will remain—that is, to transmit power at great distances. Men will go to the waterfalls, to the tides, which are the stores of an infinitesimal part of Nature's immeasurable energy. There will they harness the energy and transmit the same to their settlements, to warm their homes by, to give them light, and to keep their obedient slaves—the machines—toiling. But how will they transmit this energy if not by electricity? Judge then, if the comfort, nay, the very existence, of man will not depend on electricity. I am aware that this view is not that of a practical engineer, but neither is it that of an illusionist, for it is certain that power transmission, which at present is merely a stimulus to enterprise, will some day be a dire necessity.

It is more important for the student who takes up the study of light phenomena to make himself thoroughly acquainted with certain modern views than to peruse entire books on the subject of light itself, as disconnected from these views. Were I therefore to make these demonstrations before students seeking information—and for the sake of the few of those who may be present, give me leave to so assume—it would be my principal endeavour to impress these views upon their minds in this series of experiments.

It might be sufficient for this purpose to perform a simple and well-known experiment. I might take a familiar appliance—a Leyden jar—charge it from a frictional machine, and then discharge it. In explaining to you its permanent state when charged and its transitory condition when discharging, calling your attention to the forces which enter into play and to the various phenomena they produce, and pointing out the relation of the forces and phenomena, I might fully succeed in illustrating that modern idea. No doubt, to the thinker this simple experiment would appeal as much as the most magnificent display. But this is to be an experimental demonstration, and one which should possess besides instructive, also entertaining features, and as such a simple experiment, such as the one cited, would not go very far towards the attainment of the lecturer's aim. I must therefore choose another way of illustrating, more spectacular, certainly, but perhaps, also, more instructive. Instead of the frictional machine and Leyden jar, I shall avail myself in these experiments of an induction coil of peculiar properties, which was described in detail by me in a lecture before the London Institution of Electrical Engineers, in February, 1892. This induction coil is capable of yielding currents of enormous potential differences, alternating with extreme rapidity. With this apparatus I shall endeavour to show you three distinct classes of effects, or phenomena, and it is my desire that each experiment, while serving for the purposes of illustration, should at the same time teach us some novel truth, or show us some novel aspect of this fascinating science. But before doing this, it seems proper and useful to dwell upon the apparatus employed, and method of obtaining the high potentials and high-frequency currents which are made use of in these experiments.

On the Apparatus and Method of Conversion.

These high-frequency currents are obtained in a peculiar manner. The method employed was advanced by me about two years ago in an experimental lecture before the American Institute of Electrical Engineers. A number of ways, as practised in the laboratory, of obtaining these currents either from continuous or low-frequency alternating currents is diagrammatically indicated in Fig. 1, which will be later described in detail. The general plan is to charge condensers from a direct or alternate current source, preferably of high tension, and to discharge them disruptively while observing well-known conditions necessary to maintain the oscillations of the current. In view of the general interest taken in high-frequency currents and effects producible by them, it seems to me advisable to dwell at some length upon this method of conversion. In order to give you a clear idea of the action, I will suppose that a continuous-current generator is employed, which is often very convenient. It is desirable that the generator should possess such high tension as to be able to break through a small air-space. If this is not the case, then auxiliary means have to be resorted to, some of which will be indicated subsequently. When the condensers are charged to a certain potential, the air or insulating space gives way and a disruptive discharge occurs. There is then a sudden rush of current, and generally a large portion of the accumulated electrical energy spends itself. The condensers are thereupon quickly charged, and the same process is repeated in more or less rapid succession. To produce such sudden rushes of current it is necessary to observe certain conditions. If the rate at which the condensers are discharged is the same as that which they are charged, then, clearly, in the assumed case the condensers do not come into play. If the rate of discharge be smaller than the rate of charging, then, again, the condensers cannot play an important part. But if, on the contrary, the rate of discharging is greater than that of charging, then a succession of rushes of current is obtained. It is evident that, if the rate at which the energy is being dissipated by the discharge is very much greater than the rate of supply to the condensers, the sudden rushes will be comparatively few, with long-time intervals between. This always occurs when a condenser of considerable capacity is charged by means of a comparatively small machine. If the rates of supply and dissipation are not widely different, then the rushes of current will be in quicker succession, and this the more, the more nearly equal both the rates are, until natural limitations incident to each case and depending upon a number of causes are reached. Thus we are able to obtain from a continuous-current generator as rapid a succession of discharges as we like. Of course, the higher the tension of the generator, the smaller need be the capacity of the condensers, and for this reason, principally, it is of advantage to employ a generator of very high tension. Besides, such a generator permits the attaining of greater rates of vibration.



Plan of Connections Used in the Conversion by Means of the Disruptive Arc Discharge.

The rushes of current may be of the same direction under the conditions before assumed, but most generally there is an oscillation superimposed upon the fundamental vibration of the current. When the conditions are so determined that there are no oscillations, the current impulses are unidirectional, and thus a means is provided of transforming a continuous current of high tension into a direct current of lower tension, which I think may find employment in the arts.

This method of conversion is exceedingly interesting, and I was much impressed by its beauty when I first conceived it. It is ideal in certain respects. It involves the employment of no mechanical devices of any kind, and it allows of obtaining currents of any desired frequency from an ordinary circuit, direct or alternating. The frequency of the fundamental discharges depending on the relative rates of supply and dissipation can be readily varied within wide limits by simple adjustments of these quantities, and the frequency of the superimposed vibration by the determination of the capacity, self-induction, and resistance of the circuit. The potential of the currents, again, may be raised as high as any insulation is capable of withstanding safely, by combining capacity and self-induction, or by induction in a secondary, which need have but comparatively few turns.

As the conditions are often such that the intermittence or oscillation does not readily establish itself, especially when a direct current source is employed, it is of advantage to associate an interrupter with the arc, and I have, some time ago, indicated the use of an air-blast or magnet, or other such device readily at hand. The magnet is employed with special advantage in the conversion of direct currents, as it is then very effective. If the primary source is an alternate-current generator, it is desirable, as I have stated on another occasion, that the frequency should be low, and that the currents forming the arc be large, in order to render the magnet more effective.

(To be continued.)

HANLEY.

The following is the borough engineer's (Mr. J. Lobley, M.Inst.C.E.) report upon the electricity works at Hanley up to present date :

A provisional order was obtained in 1891, enabling the Council to produce, distribute, and sell electric energy within the borough. Fuller particulars of the requirements and conditions of this order may be found in my report of last August. In September, 1892, the Council accepted the tender, amounting to £15,760, of the Brush Electrical Engineering Company for the boilers, engines, dynamos, mains, and sub-station transformers requisite to deal with the compulsory area lighting, both public and private, in its first stages.

The Board of Trade has approved of the scheme proposed, which is that known as high-pressure alternating current, with transformers at sub-stations, from which low-pressure distributing mains are laid to customers' premises. The reasons that influenced the Council in selecting this system as against a continuous-current scheme, as being more suitable for a district like Hanley, were principally : 1. The works could be placed away from the centre of the town, and where land is less valuable, and where consequently extensions could be more readily made as required. 2. Management expenses of one central station would be much less than at several, such as would almost necessarily be required under a low-pressure scheme as different parts of the borough required to be supplied.

The extreme north-eastern corner of the Park Estate, adjoining the canal near Joiner's-square, has been selected as the site for the electricity works. The distance from this position to the Town Hall, measured along the line of mains, is 1,000 yards, and to the northern extremity of the compulsory area, the distance is about one mile. It was expected that the extra cost of mains would have made this position more costly, so far as the compulsory area was concerned, than a low-pressure scheme with works in the centre of the town. Such, however, was not the case; the extra cost of the high-pressure mains being covered by the saving in the low-pressure mains. By the system adopted there are to be six sub-stations. The longest distances for consumers to be served by low-pressure mains average 120 yards, capable of reduction as custom increases. Under a low-pressure system the longest distances average 400 yards, and are incapable of reduction. This applies to the compulsory area only. For districts outside this area the greater economy of the high-pressure system is still more apparent. The site for the electricity works will be found to be very conveniently situated and but little removed from the actual centre of the area of supply. Further advantages accrue from its proximity to the canal for the supply of coal and water for condensing engines. The capacity of the high-pressure mains at present to be laid is 150 amperes at 2,000 volts pressure. To give the same results as to light by the low-pressure two-wire system, it would require 400 times the same weight in copper in the mains, or with the three-wire system it would still require 100 times the weight in copper, with the addition of the third or neutral wire. This enormous amount of copper buried in mains would have to be continued for every separate main that would in future be required for the works. The only way to avoid it is to multiply the number of works or to abandon low-pressure supply.

A few words as to the details of the mains: The high-pressure mains are concentrically arranged in one cable with insulating material between the two sets of copper strands—the whole being insulated and protected by outer coverings. This cable is drawn into 3in. cast-iron pipes, and, as there will be no connections made with it between the junction-boxes or transformer stations, it can be drawn out again and a larger size replaced when the demand requires it. This cable forms a ring main from the works, *vid* Bethesda-street and Piccadilly, to the Market square and returning *vid* Tontine-street and Lichfield-street. Any section can be disconnected without interrupting the supply to any consumer. The low-pressure distribution mains are not concentric, but are laid double in cast-iron troughs, afterwards filled up solid with pure bitumen. These cannot be drawn out and enlarged, and in any description of conduit, the connections to the different premises renders such a course very costly and difficult. The capacity of these mains is practically increased to any extent desired by reducing the area served by them. This is done by adding transformer stations at the points of most demand.

The Local Government Board, after an enquiry, have consented to the Council borrowing the sum of £21,000, repayable in 25 years, for the purposes of the order. A contract has been entered into with Mr. C. Cornes for the erection of the buildings for the sum of £2,990. Considerable difficulties have been occasioned in preparing the foundation for the chimney shaft and boiler-house, owing to the outcrop of carbonaceous marl and combustible material. This has been removed and the work is in satisfactory progress. A contract has been entered into with Messrs. John Warner and Son for a seven-ton travelling crane, for the sum of £137. 10s.; and with Mr. Thomas Cass, of Bolton, for supplying the three Lancashire boilers now being made, with his mechanical stokers, for the sum of £270. On April 25 I read the following report on the street-lighting by electricity to the General Purposes Committee:

Public Street-Lighting (*within or adjacent to the Compulsory Area*). The contract includes provision for 20 arc lamps of 2,000 nominal candle-power each—*i.e.*, 500 watts. These are arranged in series, supplied with electricity by a special cable from a continuous-current dynamo. A second engine and dynamo is provided as reserve. The same plant is capable of working 30 arc lamps of 1,200 nominal candle-power each (333 watts), and, in order to compare the relative advantages, I estimate the annual cost of maintenance in both cases, as follows: These estimates are based on the proviso that a general supply of electricity is established, and as the comparative power of the plant is 600 h.p. for the general supply, against 20 h.p. for the street-lighting (excluding the spare plant in both cases), the wages of one man is sufficient to allow for lamp trimming and labour generally. Less than half his time would be required on the lamps, and the remainder available for general assistance would more than set off against the very slight additional work at the generating station caused by the street-lighting. The cost of fuel is put down at 4lb. of coal per horse-power per hour. In comparing this with the general supply it must be noted that for street-lighting the load is either all on or all off. There are no fluctuations to provide for, or pressure to be kept on in the mains during the day—in fact, the electricity is produced regularly, and under the most economical conditions. Twenty arc lamps 2,000 nominal candle-power (500 watts). One horse-power is 746 watts. It will be allowing a large margin if it is taken that each lamp will use 1 h.p. If working from sunset to sunrise, 4,000 hours per annum is a little more than is at present calculated for gas lamps. It is, therefore, safe to take that figure.

20 lamps = 20 h.p. at 4lb. coal per horse-power.
= 4,000 × 80 = 320,000lb. = 144 tons nearly.

144 tons at 6s. 8d.	£48
Carbons	64
Wages, trimming, etc.	70
Oil and waste	10
Interest and repayments	90
Contingencies	22
	£304

The actual amount paid for the lighting by gas in lamps that would be dispensed with is £219. 1s. 9d. In comparing the two amounts it must be noted that the majority of the present gas lamps are turned down at 11 p.m. A similar arrangement with respect to the electric light would result in bringing the annual cost below what it now is for gas.

Alternative Scheme.—Thirty arc lamps of the smaller size would also require under 20 h.p., and consequently the same amount of fuel, etc. Adding £30 extra for carbons and contingencies, the annual cost is brought up to £334. These would displace lamps now costing £300. 19s. 9d., and again it must be noted that the electric light is for all-night use, but the majority of the gas lamps are lowered at 11 a.m. The specification and contract enables the Council to adopt either of these schemes. Beyond the interest and repayment item, it is not necessary to include further for repairs and depreciation; inasmuch as in comparing the cost of gas lighting, no account has been taken of the first cost of the large lamp-posts and lanterns and fixing. Interest on the boilers and buildings is not included, inasmuch as that must be met out of the revenue account of the electricity supply, whether street-lighting is undertaken or not. If it be considered right to charge the street-lighting with anything on this account, it should not be more than its due proportion in horse-power before mentioned, which would amount to £20 per annum.

PROPOSED SCHEME FOR A CIRCUIT OF 20 ARC LAMPS.

No.	Situation.	A. Gas 25ft. all night.	B. Gas 25ft. to 11 p.m., 5ft. after.	C. Gas 20ft. to 11 p.m., 5ft. after.	D. Gas 15ft. to 11 p.m., 5ft. after.	E. Gas 20ft. to 11 p.m., 5ft. after by meter.	F. Gas 2ft. meter Victoria Hall.	G Gas, ordinary lamps.
1	Regent-square	1	—	—	—	—	—	—
2	Albion-street	—	—	—	—	2	—	—
3	Top of Broad-street	—	1	—	—	—	—	1
4	Piccadilly	—	—	—	3	—	—	—
5	Pall-mall	—	—	—	2	—	—	—
6	Top of Brunswick-street	—	—	1	1	—	—	—
7	,, Clough-street	—	—	—	1	—	—	—
8	Bottom of Trinity-street	—	1	—	1	—	—	2
9	Miles Bank	—	1	—	—	—	—	1
10	Crown Bank	1	—	—	—	—	—	—
11	Fountain-square	—	1	—	—	—	—	—
12	Market-square	1	—	—	—	—	—	—
13	,, ,,	1	—	—	—	—	—	—
14	Tontine-square	—	1	—	—	—	—	—
15	Percy-street	—	—	—	2	—	—	—
16	Parliament-square	—	1	—	—	—	—	—
17	Albion-square	—	1	—	—	—	—	—
18	Lichfield-street Baths	—	—	—	—	—	—	2
19	Mollart-street	—	—	—	—	—	—	1
20	Derby-street	1	—	—	—	—	—	—
		5	7	1	10	2	—	7

Ten additional arc lamps if a circuit of 30 is adopted, as follows:

21	Bagnall-street	—	—	—	—	—	4	2
22	Albion-street	—	—	—	3	—	—	—
23	Piccadilly	—	—	—	1	—	—	—
24	,,	—	—	—	1	—	—	—
25	Bottom of New Hall-street	—	—	—	—	—	—	3
26	Top of Hope-street	—	1	—	—	—	—	—
27	Bottom of Lamb-street	—	—	—	1	—	—	—
28	Trinity-street	—	—	—	—	—	—	2
29	Crown Bank	—	—	—	2	—	—	—
30	Upper Market-square	—	1	—	—	—	—	—
		5	9	1	18	2	4	14

Total 53

ANNUAL COST OF EACH GAS LAMP.

Class.	£	s.	d.
A	13	9	5
B	8	1	10
C	6	18	5
D	5	2	0
E	7	2	7
F	2	10	0
G	3	0	0

Incandescent Lamps for Side Street-Lighting.—Within and adjacent to the district through which the electric light mains will pass are other existing gas lamps, in addition to the 53 lamps of various sizes that will be dispensed with by the establishment of the 30 arc lamps. There are 40 ordinary (five cubic feet per hour) gas lamps within a short distance of the trenches about to be opened up to lay the cables for the general supply, and it is desirable to consider the advantages or otherwise of supplying these positions with incandescent lamps. Various ways of doing this are open for adoption. The first that naturally suggests itself of supplying from the general low-pressure mains, and sending round the lamplighters to light and extinguish, may be soon discarded, as it will be seen that the cost of a better system will be less. Street-lighting by incandescent lamps has not been a success in England, owing to the fact that they have not been allotted their proper place. When placed in leading thoroughfares, such as in Holborn or at Leamington, the public expected a greatly increased illumination. This not being the case, disappointment followed. At present, it is generally conceded that arc lamps should be used for leading thoroughfares, but there are many positions, particularly in side streets, where the establishment of such a lamp is out of the question, and where an ordinary gas-burner, or a 60-watt (16-c.p.) incandescent lamp would suffice. I propose to lay in the same cast-iron trough, with the general supply mains, where required, two separate insulated cables of small size—the whole being afterwards filled up as before described with bitumen. The cost of this, if done with the general work of laying the mains, averages 9d. per yard. In other trenches about to be made for the primary mains and arc light cable, the special cables will be drawn into 1in. wrought-iron pipes. The cost of this averages 2s. per yard. The cost of the low-pressure mains for the 40 lamps, I estimate at £200; the lamps being arranged in simple parallel, and supplied through the special mains from each sub-station. I have given the series system of lighting these incandescent lamps careful attention—having seen it in operation in America and elsewhere. By this method the current at high pressure is taken from the primary mains and passed through each of the 20 lamps in succession. In case of failure of a lamp, the whole 20 would be extinguished if complicated arrangements and duplicate lamps at each post were not provided. The saving through being able to use a smaller-sized cable is more than lost by the cost of these arrangements. It is doubtful, also, whether it would be permitted to take a high-pressure cable in the same trough as the general low-pressure mains. A number of lamps, not exceeding 20, supplied from special transformers at each sub-station, has been selected as affording a ready means of comparison between the cost of the series and the parallel arrangements. It will only be necessary to use three sub-stations to supply the 40 lamps. Whether the lamps are arranged in series or in parallel, I propose to use a special high-pressure concentric cable, extending from the works and drawn into the ring of cast-iron pipes provided for the general primary cable, the two cables being first securely tied together before being drawn in. For mechanical reasons this cable ($^7/_{18}$ concentric), at 2s. per yard, is as small as could be advisedly used. It would, however, be capable of supplying current to more than 400 lamps. I estimate the cost of this, together with the special transformers, at £400. It is not absolutely essential that this should be provided at present for the small number of 40 now contemplated, but if postponed the cost of ultimately laying would be considerably increased, and the interest on the outlay would not be altogether saved, as there would be the necessity of sending round the lamplighter night and morning to switch on and off the lamps at the sub-stations. The low-pressure special wires for incandescent street lamps is the only question pressing for settlement. I estimate the cost of fitting-up each lamppost with incandescent lamp, no switch or complication of any kind being required, at not exceeding £1 per lamp. Total first outlay, £240.

ANNUAL COST OF MAINTENANCE FOR 40 INCANDESCENT STREET LAMPS, OF 60 WATTS EACH.

Interest and repayment on first outlay	£30
This would repay the amount in 10 years.	
Coal—45 tons at 6s. 8d.—namely: 5 h.p. at 5lb. per horse-power per hour for 4,000 hours	15
Oil, waste, water, and stores, 9,600 units at ⅛d.	5
Salaries and wages at ½d.	20
Lamp renewals at 6s. per post	12
Painting, etc., at 3s. per post	6
Interest and repayment of cost of electricity works at 5s. per lamp	10
Total annual cost	£98

The present cost of gas for these 40 lamps is £120. The difference of £22 might fairly represent the charge to be made for the special high-pressure ring main and transformers; the whole burden of which should clearly not be charged against the 40 lamps. So far it appears that the charge from gas to electricity shows no difference in cost; but the first outlay would be paid off in 10 years and the cost of the high-pressure special main be shared most probably amongst a greater number, thus bringing down the annual cost of the 40 lamps to £80. I have made the estimate in this form in order to show that the Electric Lighting Committee will not lose if they charge the street-lighting account the same amount that is now being paid for gas—namely, £3 per lamp—the same remark applying to the arc lamps, the charge being £11 per 400-watt lamp, giving 1,200 c.p. to 1,600 c.p, and burning all night. An important consideration is the fact that the Corporation in this matter would become their own customers at the early stage in the establishment of the business. The charges for interest on capital outlay are really profit, as they must be incurred whether the street-lighting be undertaken or not. A great advantage in the system of incandescent electric street-lighting proposed is the ease by which any required size of lamp (up to 40 c.p.) can be used. If two 30-watt lamps can be placed to better advantage than one of 60 watts, it can readily be done, and the cost is not materially affected. A 60-watt lamp will compare most favourably with the ordinary street gas lamp in the light given. A 120-watt lamp (32 c.p.) can be placed in suitable positions, and the extra cost would be little more than for fuel and stores. I estimate this at 15s. per annum for a 60-watt lamp, so that doubling the light will therefore only increase the cost by 15s. With gas the increased cost is not less than 50s. per annum for each additional 5ft. per hour consumed.

JOSEPH LOBLEY, Borough Engineer and Surveyor.

At a meeting of the Town Council on May 22, 1893, it was decided to provide 30 arc lamps of 1,200 nominal candle-power, and to lay the cables for incandescent lamps at the same time as the other mains.

Since the foregoing report was laid before the committee, I have devised a system that will render the provision of the special high-pressure mains for the incandescent lamps for street-lighting unnecessary. There will also be no need for special transformers. This will reduce the first outlay by £400. This system will also reduce the average lengths and sizes of the low-pressure special mains for this purpose, as the distance along such cables to the furthest lamp need not exceed 200 yards. This reduces the cost of the special mains to £170, and the estimated annual cost of maintaining the 40 lamps to £89. There is thus a margin of £31 to cover contingencies and the extra cost of the arc lights burning all night.

The following extract from the provisional specification explains the apparatus: "This invention for improvements in lighting and extinguishing electric lamps for street-lighting relates to districts which are lighted partly by arc lamps and partly by incandescent lamps.

"Where arc lamps exist in series controlled from the central station and have independent continuous-current plant and cables, the arrangement is as follows: The arc lamp cable is passed through the apparatus (which are placed at junction-boxes or sub-stations), and whenever the arc lamp current is turned on, the apparatus switches on the current from the general supply low-pressure mains to the incandescent lamps arranged in parallel. These should not exceed 20 16-c.p. lamps of one connection, so that the distance of the furthest lamp should not exceed 200 yards. When the arc lamps are turned out the apparatus switches off the current supplying the incandescent lamps, which are thus automatically lighted and extinguished by closing or opening the arc light circuit at the electricity works. The apparatus consists of a solenoid or electromagnet operating a lever; the current of the arc lamps energises the solenoid or electromagnet, lifts the lever, and by a mercurial or other switch closes a low-pressure circuit for the incandescent lamps." Patent applied for, but the free use reserved for Hanley.

ST. PANCRAS.

By the courtesy of Mr. Thomas Eccleston Gibbs we have been favoured with a copy of the joint report of the Electricity and Public Lighting Committee and a special committee of this Vestry. The committee have been considering three descriptions of work which it is proposed to combine under one system—viz., the collection of house and street refuse, the burning of such refuse, and the utilisation of the heat obtained from such burning for the generation of electricity. The report consists of several reports, of which the supplementary joint report by Prof. Henry Robinson and Mr. W. N. Blair (engineer to the Vestry) is the most interesting to our readers, and this is as follows:

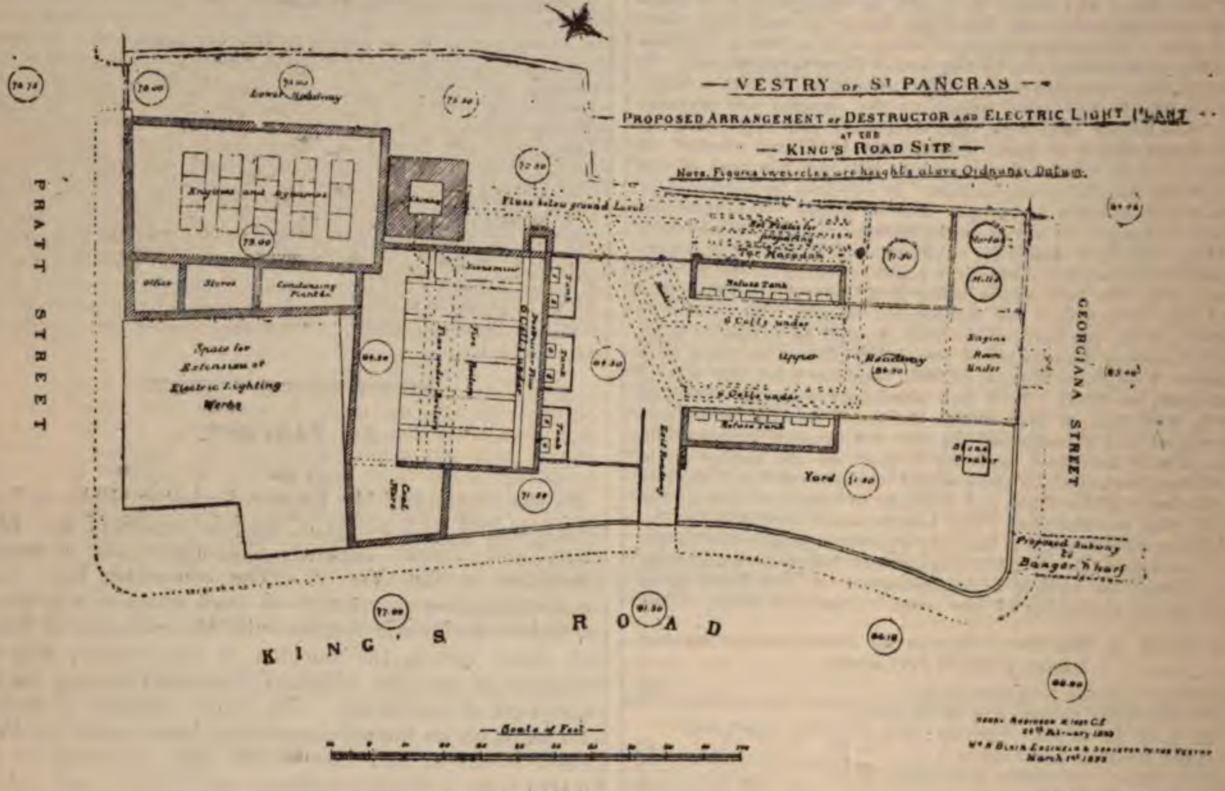
We have given careful consideration to the possibility of combining an electric lighting station with the dust destructor establishment proposed to be formed on land belonging to the Vestry in King's-road, and the accompanying plan will show the general arrangement of the proposed works. The principle of the destruction of the refuse by destructor cells is now well recognised, and it is being carried into effect by local authorities throughout the kingdom. The portion of the site to be occupied in connection with the destructor cells is that adjoining Georgiana-street, which is practically at the same level as the upper roadway, to be entered therefrom by two gateways, with a weigh office between, and in one of the gateways a weighbridge will be provided. This upper roadway is proposed to be constructed of rolled steel joists and concrete, supported on cast-iron columns and stanchions, and the roadway will be paved with granite setts. The tipping kerbs will be of timber secured to the iron framing, and the sides of the roadway throughout the rest of their length will be protected by a double rail of wrought-iron piping. Below this roadway 12 destructor cells are arranged, six on either side, to which refuse will be supplied by tipping over the side of the road into tanks attached to the cells. The heat from these cells can be utilised in various ways, such as by passing it through the boilers and economiser required by the electric light station, referred to in detail hereafter, or by carrying it under a floor of iron plates on which can be prepared tar macadam or asphalte, or through a multitubular boiler, by which power may be produced to drive the machinery, such as mortar-mills, clinker-crushers, and a stone-breaker necessary for dealing with the clinker, etc. These machines, which would only utilise a comparatively small amount of the heat, are placed on the Georgiana-street front of the lower yard. At the south end of the upper roadway six more cells are placed in direct communication with the five boilers and the economiser to produce steam for the electric lighting. An exit roadway into King's-road is provided to allow empty vans to leave the premises without interference with those entering or tipping.

The space occupied by the cells, refuse-tanks, and roadway adjoining will be enclosed and covered by iron-framed roofs, portions of which are provided to be glazed to give sufficient light without windows in the walls, and the work to be carried on will therefore be less likely to cause complaint of noise or dust. The cells are designed to give the most perfect combustion to as large a quantity of refuse as possible with the least amount of labour, and with these objects in view a continuous supply of refuse to the fires will be effected by means of mechanical action applied to the fire-bars, and by the application of forced draught from a fan when necessary to increase the temperature. As soon as the flues leave the several blocks of furnaces they will be dropped, so as to pass along below ground to the chimney. Proper access to the flues will be arranged to facilitate the removal of dust. A chimney, which will serve for the boilers as well as for the cells, is based near the boiler-house, and is proposed to be carried up from a concrete foundation 36ft. square to a height of about 200ft. above the yard level. The base will be built square and the shaft octagonal, the flue is 7ft. 6in. diameter, and lined with firebrick for about 80ft. above ground. A retaining wall, sufficiently high to prevent the works being overlooked, is provided to enclose the site, and where exposed above the road-levels will be panelled to give it a better appearance. The subway under Georgiana-street, giving direct access to Bangor Wharf, is proposed to be 11ft. wide and 10ft. 6in. high, with an arched roof, and both arch and sides above a dado of blue brick will be lined with white glazed brick. On the west side a footway 3ft. wide will be formed, and on the east side a guard kerb 1ft. wide, leaving a cart road 7ft. wide. The construction of this subway involves some little alteration to the building adjoining, which is intended to be converted into one tenement and utilised as storekeeper or foreman's house. The entrance to Bangor Wharf for ordinary work will be made on the site of the small stable now adjoining this house on the west side, and provision is made in the estimate for paving the yard, clearing out the basin, and repairing the wall along the canal and basin. The boiler-house and premises at the canal side of the yard must be demolished to allow the construction of the approach to the subway. The line of frontage to King's-road is set back to give an equal width to the road from Pratt-street to the canal bridge, and the cost of the alterations to the roadway is included in the estimate, although the work should rather be regarded as a public improvement than as chargeable to the proposed establishments. If the capacity of the 18 cells thus provided be taken at 10 tons per cells per day (and there is every reason to believe that the consumption of refuse will not be below this amount), the depôt will be capable of disposing of 1,080 tons of refuse during the week, and 60 tons would be burnt in the cells under the boilers on Sunday to keep the electric lighting going. This makes the capacity of the depôt 1,140 tons per week without involving any unnecessary Sunday labour. The following is prepared from information obtained last year, and shows the quantity of house refuse collected in the various wards during a summer week and a winter week :

QUANTITY OF HOUSE REFUSE COLLECTED.

District.	Population.	Refuse in tons in summer week.		Refuse in tons in winter week.	
Ward 1	59,233	370	1,084	462	1,354
,, 2	19,284	137		171	
,, 3	34,030	164		205	
,, 4	19,661	140		175	
,, 5	21,758	143		179	
,, 6	26,636	130		162	
,, 7	22,542	125		156	
,, 8	31,234	127		159	
	234,378	1,336		1,669	

From these figures it will be seen that during probably eight months of the year the refuse from Wards 1, 2, 3, 4, 5, and 6 could be disposed of at the depôt, but during the winter months it would probably be necessary to find other means of getting rid of the refuse of Ward 1. The quality of refuse, however, being superior in winter, some part of it might with advantage be burnt in the boiler furnaces, and in this manner some of the surplus would be disposed of. The boilers could probably take 100 tons of refuse per week, using it only when a high rate of evaporation is not required and resorting to coal when the heavy load comes on in connection with electric lighting. This arrangement would save £10 to £15 per week in coal and disposal of refuse by carting away. It might be found undesirable to burn ordinary summer refuse in the boiler furnaces as the amount of combustible matter which it contains might not be capable of raising the temperature sufficiently to destroy the fumes without a firebrick reverberatory arch over the furnace as in the destructor cells.



It is desirable for the committee to give consideration to the expediency either of carrying out another electric lighting station or of increasing the plant at the present station. In this connection it may be pointed out that whereas in other parts of the metropolis the supply given by private companies is extending steadily, there can be no reason for assuming that St. Pancras is exceptional, and that it has reached a limit beyond which it would be impolitic to pass, having in view the obligation that exists under the provisional order to supply electricity to the whole district. The following points should be borne in mind : 1. The present station is only capable of serving 10,000 lamps simultaneously, or about 13,300 lamps installed. 2. At the present time there are about 11,000 lamps installed. 3. That this demand has arisen in less than 18 months. 4. That a new station cannot be got to work in less than 18 months from the present time.

The points to be decided are : Will the demand increase during the next 18 months to the extent of more than 2,300 lamps, and is it desirable to extend the mains beyond the present limited area of supply ? In the event of its being considered that an extension is desirable, the scheme presented now in connection with the King's-road destructor works would meet the case in a most economical manner. The proposal to establish a refuse destructor station on the King's-road property of the Vestry affords an opportunity for the erection of a second electric lighting station, which can be worked with great economy. By combining the two operations at one station the capital outlay in respect to the production of electricity will be somewhat less than would be the case if an independent site had to be utilised. The obvious desirability of utilising the waste heat produced by the destruction of town refuse for raising steam is now well recognised, and has been carried into effect for various purposes. There is therefore no doubt whatever as to the practicability of raising steam and applying it to engines driving dynamos for generating electricity. The scheme provides for plant to serve 4,800 lamps installed, thus bringing up the capacity of the Vestry's electricity generating plant to 18,100 lamps, or 13,600 lamps simultaneously in use, as against the 10,000 lamps at present. The engine and boiler houses are designed to contain plant to serve double the number of lamps provided for at first, so that future extensions, as hereinafter indicated, can be carried out at any time rapidly and with great economy. It may be observed that the extensions now under consideration are such as are inevitable if the St. Pancras Vestry are to meet the demands which exist in their district. To stand still may involve the question whether the Vestry are *bonâ fide* carrying out their provisional order.

The new mains proposed to be laid in connection with the first instalment of the King's-road works are as follows: A feeder to the Cobden sub-station passing along Pratt-street, Great College-street, and Crowndale-road. A second feeder passing northwards up Great College-street and Kentish Town-road to the corner of Prince of Wales-road. Distributing mains would be laid along the lines of these two feeders, and also in Kentish Town-road up to the Midland Railway, in Camden-road from The Red Cap to the North London Railway, and from the Cobden sub-station to the Clearing-house along Eversholt-street and Seymour-street. The feeder to the Cobden sub-station would enable the new plant to serve the light load of the whole district that is now served from Stanhope-street and the distributing main to the Clearing-house would not only facilitate this operation, but would divide the full load there between Stanhope-street and King's-road with great economy and convenience of working, as it is a great advantage to have the two stations connected by trunk mains so as to enable them to assist one another. These mains and feeders would serve 8,000 lamps simultaneously, without the assistance of new sub-stations, and more than double this number when battery stations are established.

The site is laid out for five Lancashire boilers and five engines, of about 200 h.p. each, driving dynamos. In the first instance, however, only three engines and three boilers need be put down. The boilers would be heated by the gases from the destructor cells passing round the outer shell and escaping by the main flue, crossing under the front end of the boilers to the chimney. The power available from the destructors will be not less than 300 h.p. with the first instalment of three boilers, end 500 h.p. with the complete set of five boilers. Arrangements are also provided for firing these boilers in the usual manner by hand or by mechanical stokers with coal, so that steam may be more rapidly raised to meet any sudden demand due to fogs, and at times of maximum load. The engine and dynamo house would be built adjoining the boiler-house, and with the office of the manager of the station will extend to Pratt-street. A small coal-store is provided adjoining the boiler-house, and is entered from King's-road, and by means of a hydraulic lift, actuated by the water descending from the coolers to the condensing-tank, coal will be delivered to the hopper supplying the mechanical stokers, or to the floor of the boiler-house. The entire supply of the High-street district would at once be taken up by the new station in King's-road, and being only about one-third of the distance from King's-road than it is from Stanhope-street station, the supply would be carried on at a much better efficiency, while the plant at Stanhope-street could supply a larger number of lamps in its own neighbourhood. It is important that provision should be made for meeting the increasing demand in the High-street district, as the number of lamps which can be served in this district from Stanhope-street has nearly been reached, so that it will soon be necessary to refuse new customers unless fresh provision is made. The busiest part of the Kentish Town-road, which is now unsupplied, can be served very well from King's-road, and this will be one of the most remunerative parts of the parish. The supply over the whole system of mains during periods of light load could be given either from Stanhope-street or King's-road; but it could be done more economically from King's-road, as the destructors would be working continuously, and would be yielding a large part, if not the whole, of the heat required for raising steam to meet the day demand.

The estimated cost of erecting destructors, and the various works in connection therewith, is as follows:

Excavation of site, drainage, paving, and boundary walls	£2,450	0	0
Destructor cells, refuse-tanks, gearing, etc.	4,500	0	0
Upper roadway, buildings, flues, etc.	3,350	0	0
Chimney shaft, including excavation and foundation	3,100	0	0
Boiler, engine, mortar mills, stone-breaker, etc.	1,100	0	0
	14,500	0	0
Subway under Georgiana-street	1,150	0	0
Improvement of Bangor Wharf	900	0	0
Alteration, etc., to house in Georgiana-street	120	0	0
Alteration to roads adjoining the site	600	0	0
	17,270	0	0
Add 10 per cent. for contingencies	1,730	0	0
Total	£19,000	0	0

The cost of disposing of the refuse is at present about 3s. 9d. per ton, including collection, and the cost of dealing with the same quantity at the depôt may be taken at 1s. per ton, to which may be added the cost of collection, estimated at 1s. 6d. per ton, for, with the proposed depôt being so central to the district served, there will be a reduction on the present cost, as the number of journeys per day will be increased. This makes the cost 2s. 6d. per ton. as compared with 3s. 9d. per ton at present, or a saving of 1s. 3d. per ton, which amounts to about £3,700 per annum on the quantity of refuse dealt with at the depôt. There will also be a revenue of several hundreds a year from mortar, etc., produced from the clinkers, and some small value in the clinkers themselves. After allowing for the instalment for interest and repayment of capital, and also for depreciation and maintenance of works, there will remain a clear saving of £2,000 to £2,500 a year on the cost of refuse disposal only. The value of the heat utilised for electricity is estimated separately.

The following is the estimated cost of the first instalment of electric lighting works proposed to be carried out in connection with the destructors.

Buildings, with contingencies	£5,600
Central-station plant, ditto	13,170
Mains, ditto	12,130
Total	£30,900

The cost of completing the central-station plant to serve 7,500 lamps simultaneously, or 10,000 installed, would be £7,600.

The additional annual expenses of the electricity department in respect of the King's-road works will be as follows:

Instalment for 3½ per cent. interest and repayment of loan in 42 years (4·6 per cent. on £30,900)	£1,420
Maintenance and depreciation of new works	1,455
Additional staff and miscellaneous fixed expenses	1,200
Total amount of fixed expenses	£4,075

In addition to this there will be variable expenses for water, oil, coal, etc., depending upon the output and amounting to about ¼d. per unit If the whole of the proposed plant is devoted to private lighting, about 4,800 lights can be served. Assuming that the consumption will only be 37½ units per lamp per annum (the consumption in St. Pancras last year was 26 units per lamp in private houses, and was 56 units in business premises, therefore the average will be over 40 units if half the demand is in private houses), the total output would be 180,000 units per annum, which would, at 6d. per unit, yield a revenue of £4,500 per annum, while the expenses would be:

Fixed charges (as above)	£4,075	0	0
Variable expenses, 180,000 units at ¼d.	187	10	0
Total	£4,262	10	0

This shows a profit of over £200 a year, but as the day load for the whole district could be worked from King's-road with greater economy than from Stanhope-street, a further saving of several hundreds a year would accrue. Inasmuch as lamps for public lighting work for longer periods than private lights a much better result will be shown if a portion of the proposed plant were to be appropriated to work the 80 new arc lamps that have been proposed as an extension of the present public lighting. If this were carried out the number of private lights served would be reduced from 4,800 to 3,600. The output then would be:

80 arc lamps, using 2,000 units	160,000	units
3,600 incandescent lamps, using 37½ units	135,000	,,
Total	295,000	,,

At 6d. per unit this would yield £7,375 per annum, while the cost of production will be:

Fixed charges (as above)	£4,075
Variable expenses, 295,000 units at ¼d.	307
Total	£4,382

Showing a profit of £3,000 per annum, to which should be added (as before) the saving of several hundred a year on the day supply. This £3,000 a year could be devoted either to reducing both the price to private consumers below 6d. and the charge for day current below 3d., or, as an alternative, to reduce the cost of street-lighting. A much larger number of units could be generated at this station during the day and after midnight at a cost not exceeding ¼d. per unit. This power can be utilised for further public lighting, for motive power during the day, and for charging batteries when the general demand is sufficient to warrant the erection of sub-stations. Day current could therefore be supplied at 2d. per unit with a large margin of profit. The additional staff required to work the new station will consist of two shifts of stokers, drivers, and electricians. One shift could be transferred from Stanhope-street to provide for running continuously at King's-road. At times an extra man or two may be required at either station.

It is important to point out that the King's Cross district can either now or in the future be served very well from King's-road by means of a feeder laid along Pancras-road to the corner of Euston-road. This feeder should be made of sufficient size to serve about 1,500 lights simultaneously in use, which would probably meet the requirements of the district for several years to come. When the demand has reached the capacity of the feeder, a battery sub-station could be erected in the King's Cross district, and it could be charged from the feeder after midnight and during the day, the current being entirely generated by steam raised by the waste heat from the destructors. The batteries might be put in as the demand increases from 1,500 up to 4,500 lights of 16 c.p. simultaneously in use, after which additional mains would be required from the generating station and additional generating plant. It might then be desirable to introduce high-tension currents to work continuous-current transformers at the sub-station and to charge the batteries, but it would not pay to establish a sub-station in this district at the outset either for batteries or transformers. If these works were carried out as indicated, the whole of the south-eastern district could be supplied for many years to come without the establishment of another generating station. A good reason for deferring the erection of battery sub-stations for a few 'years is that the manufacture of batteries is steadily undergoing improvement in which a large field is still open, whereas there is very little room for improvement in central-station generating plant. The cost of maintenance and depreciation of batteries is also much greater than that of heavy low-tension mains, which may be used at first to serve longer distances than will be the case when customers are more numerous and provision has to be made to supply the more distant parts from sub-stations.

It is preferable to develop the electric lighting business in the manner indicated rather than by introducing high-tension plant at the outset with a view to reducing the size of the street mains, as it avoids the necessity for establishing sub-stations until there is a profitable amount of work for them to do, and it also to a large extent avoids the necessity for disturbing the streets a second time to enlarge or duplicate the distributing mains. It is actually the most economical system, because the first cost of the heavy low-tension mains is not greater than that of the smaller low-tension mains added to the cost of the high-tension primary mains and sub-station plant. The efficiency of direct distribution at low tension, under these circumstances, is far higher than by high tension with transformers, particularly at light loads. The northern part of the parish can be served either by high tension from King's-road, or, preferably, by a third generating station combined with refuse destructors, for dealing with the refuse of that district, which is not provided for in the King's-road destructor scheme.

In conclusion, we are quite of opinion that the combined works herein described can be wisely proceeded with by the Vestry, and that the economies indicated are such as to render the establishment one that would prove of considerable financial benefit to the parish.

THE ELECTRICAL TRADES SECTION OF THE LONDON CHAMBER OF COMMERCE.

A meeting of this section took place last Friday at the Chamber of Commerce, Eastcheap, Major S. Flood-Page occupying the chair. Among those present were Major-General Webber, Messrs. Crompton, Edmunds, Erskine, Beaumont, Morse, Garcke, and Gaine.

The **Chairman** said although it was a long time since a meeting of the section took place, the Council had not been idle, having held 13 meetings since the minutes were recorded. He directed attention to a matter which concerned not only the electrical industry, but also all trades—namely, the London Chamber of Arbitration. They were aware that the Chamber of Commerce, in conjunction with the City Corporation, had formed a London Chamber of Arbitration, and had now got together something like 1,100 arbitrators, representing most of the trades in London. Down to April nine cases had been decided by that Chamber—one having been referred to it by the High Court, and the Master of the Court had expressed his satisfaction with the decision and the rapidity with which the case had been concluded. One amount in dispute had been £40,000. A clause had been agreed upon for insertion in contracts, and it was hoped that the electrical trades would endeavour to get the clause, which was as follows, inserted into contracts, as other trades were doing : "All disputes relating to contracts shall be submitted to arbitration to the rules for the time being of the London Chamber of Arbitration." The chairman had on the previous day succeeded in getting that inserted in a contract. He thought that they could claim for the system that it was expeditious, economical, and efficient, and he commended it to their careful consideration. Mr. Morse had just reminded him that the clause was irrevocable, as an Act of Parliament had been passed giving legal powers, so that when that clause was inserted in a contract, no other system of arbitration was open to them. Coming to consider the questions on the agenda, he mentioned that many meetings of the Overhead Wires Committee had taken place. He had in his hand some correspondence—which was subsequently handed round for perusal by those present—which had passed between the Board of Trade and the Institution of Electrical Engineers. With regard to that correspondence he mentioned that they were in a much better position now than they were a little time ago. At the last meeting they were doubtful whether the Institution would move in the matter; they had now moved, and by-and-by they would hear from Mr. Crompton and Major-General Webber whether they had moved fast enough and on right lines, or whether it would be necessary for the section to ask the Institution whether the latter had still something to say, or whether the members of the section should themselves, without reference to the Institution, inform the Board of Trade that they had something further to add. It would be very much to their advantage if they could work entirely with the Institution, but so far as he had been able to see the Institution had not gone as far as they could wish. There was another matter, which would be brought forward by Mr. Garcke, concerning electric traction. The principle was that power was to be *sought for a* committee to be appointed which would not come under the ordinary rules which governed sub-committees of the section, but which would have power to raise funds and take such action as might be necessary in the interests of a particular portion of the industry. Such an association already existed in the case of the supply companies, and which was outside of the Electrical Section. Those who had been connected with the section from the commencement had always felt that it was a pity that a number of associations outside the Electrical Section should be formed, and they had also felt that if it was possible and consistent with the rules of the Chamber that such a committee should be instituted in connection with the Chamber, it would be better for it to be done. It was in accordance with the rules, but if a resolution was passed to that effect, it would have to be confirmed by the Council before it would become operative. He opined that the Chamber would be much more useful to the industry if they could manage, when burning questions arose which required to be specially dealt with, that they should be dealt with in connection with the Chamber. Another matter, which some of them had seen referred to in that day's issue of the *Electrical Engineer*, was a function which was not filled either by the Chamber or the Institution. That function was the question of papers and discussions on purely commercial subjects which were really the interests of the section, but outside the special work of the Institution. If it was thought that such a thing was feasible, he would be glad if Mr. Garcke and Mr. Siemens, together with himself, would take into consideration before the coming winter the subject of two or three days' discussion, and papers read on purely commercial subjects, so as to try to fill the gap and prevent the formation of any other body to come between the Institution and the Electrical Section.

Mr. Crompton said that the position of members of the Council of the Institution prevented the disclosure of what passed at the meetings of the Council, and the same applied to the sub-committee gatherings. In this particular case he believed that the Board of Trade were particularly sensitive as to anything being divulged; and that being so, he did not know how far he could inform them. He thought, however, that Major-General Webber would confirm him in saying that when the matter was put to him at the Council the other day, he had considered the best way would be to place the correspondence in the hands of the members of the section. He thought there was no doubt that matters had advanced a step, and that the Board of Trade would ask for assistance. If not, he thought they would be entitled to call in the assistance of this body to bring pressure upon the Board of Trade to receive a deputation again, and to point out that the pressure on the industry as a whole was very great. The existing regulations were far from perfect. The Institution had not thought it right to deal with matters which appeared to be of a purely commercial nature, but only with scientific subjects.

Major-General Webber concurred with the remarks of the previous speaker as to their inability to mention what transpired at the meetings of the committee and Council, but the letters were before them. They would be satisfied to find that the Board of Trade, while demurring to make any important changes unless the necessity for them was clearly established, were quite willing to meet the wishes of the Council of the Institution, and at the same time the Board of Trade knew that they would be meeting the wishes of the Chamber of Commerce. The fundamental points discussed by the Section Committee and by that of the Institution had been brought before the Board of Trade in that correspondence. He fully believed with Mr. Crompton, that the Board of Trade would meet them in essential and important alterations.

Mr. S. Morse observed that the Board of Trade paid a good deal of attention to representations made by municipal and local authorities, and he suggested to the consideration of the committee whether they could not get such a representation from local authorities backing up the lines taken by the committee, as he felt that the Board of Trade would be much more likely to give way than if they had to decide and take the whole responsibility upon themselves.

The **Chairman** thought there was one point of satisfaction—that if the changes proposed by the Institution were made, there would be no necessity for them to take further action.

Major-General Webber did not think that the matters proposed by the Institution to the Board of Trade as being of great importance were matters in which local authorities would either be interested or be likely to see the reasons for.

Mr. R. S. Erskine observed that if the Institution did not see their way to suggest all the alterations that the Chamber had asked for, they might add that the section wished other alterations. He suggested that the Board of Trade should get a further report from them, or something to that effect.

On the proposal of **Mr. Garcke**, seconded by **Mr. Crompton**, the correspondence was referred to the Overhead Wires Committee.

Mr. Garcke said that the object of proposing the motion was the undue multiplication of societies or organisations to deal with electrical matters, and also to enhance the value and the scope of the section. He did not intend to enter into the question of the necessity for any further combination of that kind, because he wished them to accept it as a fact that the combination already existed, and that the only object in view was the desirability of merging the organisation which had been brought together into the London Chamber of Commerce. They had probably heard of the formation of the Electrical Traction Association to prepare evidence, and for other purposes, in view of the appointment of a parliamentary committee on tramways and telephones. It had occurred to him that it would be advantageous to the gentlemen who had constituted that association to carry out their purpose by means of a sub-committee of the section. Such a course was quite practicable, and in accordance with the rules of the Chamber. It only required the passing of a resolution by the section approving of the formation of a sub-committee and confirmation by the Council of the Chamber to complete the arrangement. A committee had already been formed to deal with electric traction in relation to telephones, and the representatives of the traction companies had been cordially met by those of the telephone company, with a view to some arrangements being arrived at which would render friction unnecessary, or at any rate minimise it. It seemed that the result of those negotiations had not been quite satisfactory to the electric companies, and thereupon this proposal was made to constitute a separate association. He was strongly in favour of settling any question amicably, and by negotiation. It seemed to him that a sub-committee of the section would keep that object more in view than the formation of a separate organisation. The proposal he moved was: "That this section approves of the formation of an electric traction sub-committee, with power to raise funds, engage counsel, and take such other steps as might be in their opinion necessary for the advocacy of the protection of traction interests; that the following members constitute a sub-committee, with power to add to their number: Messrs. Crompton, Morse, Kite, and Graff Baker, the Babcock-Wilcox Company, Mr. Garcke, Mr. R. O. Sellon, and the Brush Company. Such sub-committee shall be confined to the above members, and to such others as shall be elected by them, provided that no one shall be eligible for election as a member of such sub-committee who is not a member of the London Chamber of Commerce, and that the sub-committee shall be subject to the general rules of the Chamber, and shall report from time to time to the Electrical Section, and in this case the president of the Chamber, chairman of the council, and the chairman and vice-chairman of the Electrical Section shall not be *ex-officio* members of the sub-committee." The money would be raised among themselves.

Major-General Webber seconded the proposal.

Mr. W. G. Gaine asked, before the motion was put, what was the exact object and meaning of such a committee. They all knew what its intentions were. He thought the suggestion was really the formation of a protection committee to protect one interest against another interest which was also represented in the London Chamber of Commerce. It was, after all, a question between the electric traction and the telephone interests. It was possible that there might be another interest, that of railways, but in reality it lay between the two mentioned. He then referred to the insertion in Bills of clauses protecting the telephone company, to the appointment of a parliamentary committee, and to the Electric Traction Association. He wished to know whether the object of the sub-committee was solely or mainly to obtain the influence and weight at their back which the name of the London Chamber of Commerce would give them on the occasion of the enquiry of the joint committee, because if that was so he suggested that it was a most improper course to adopt, that one interest in the Chamber should seek to have the weight of the Chamber at its back against another; but unless a powerful reason, which had not been adduced, was shown that it was in the interest of the public, he thought there were absolutely no grounds for such a proposal to be made. He objected most strongly to the use of the name and weight of the Chamber to support the objects of the proposed sub-committee.

Major-General Webber presumed that the committee would act as a traction sub-committee of the Electrical Section of the London Chamber of Commerce.

Mr. Morse remarked that the fact that Sir Albert Rollit was president of the Chamber and a director of the National Telephone Company would not give greater weight to his evidence.

The **Chairman**, in reply to Mr. Gaine, observed that it would not be possible for the proposed committee to take any higher position than that of a sub-committee of the Electrical Section.

After further remarks the resolution was put, and was carried with only one dissentient.

The **Chairman** said that the next question referred to railway rates. It had originated through the correspondence between Mr. Murray and Messrs. W. T. Glover and Co. Perhaps Mr. Edmunds (of the latter firm) would open the subject.

Mr. Edmunds had little to say. The letter sent to the secretary of the section had been written by the manager of the works, but the only thing was that they were suffering along with many other people with regard to advances of rates generally.

The matter was referred to the Railway Rates Committee belonging to the section.

After a reference to the proposal of Mr. Hague at a previous meeting concerning the Bill of the National Telephone Company now before Parliament, the proceedings were brought to a close by referring to the chairman, deputy-chairman, and Mr. Crompton, the suggestion as to whether it was desirable to organise a meeting for the purpose of reading papers and discussions ,to take place next winter or spring, and to report to the Electrical Section.

Fuel Economisers.—The contracts for fuel economisers for the electric light stations at Sheffield and Kingston-on-Thames have been secured by Messrs. E. Green and Son, Limited, of Wakefield and Manchester. Most of the principal stations for generating electric power throughout the United Kingdom have now adopted the Green's system of economiser for heating the boiler feed-water. The extensive works of this firm at Wakefield is devoted exclusively to the making of their speciality. We may also mention that a large Green's economiser plant is working in connection with the intramural electric railway at Chicago, and is saving the authorities a large amount of fuel.

BUSINESS NOTES.

Rotherham.—Complaints are being made as to the time the report of the committee is delayed.

Windsor.—Mr. A. E. Farrow has been appointed engineer to the Windsor and Eton Electric Light Company.

National Telephone.—We learn that Sir Albert Rollit has become a director of the National Telephone Company.

Direct Spanish Telegraph Company.—The receipts for the month of May were £266 less than for the corresponding period.

Cuba Submarine Telegraph Company.—The receipts for the month of May were £28 more than for the corresponding period.

Eastern Telegraph Company.—The receipts for the month of May were £57,946, as against £54,842 for the corresponding period.

Shallenberger Meters.—The Westinghouse Company are selling the Shallenberger meters in England and on the Continent at the rate of about 4,000 meters per annum.

West India and Panama Telegraph Company.—The receipts of the West India and Panama Telegraph Company for the half-month ended May 31 were £3,655, against £2,315.

Kingston.—The Kingston-on-Thames Town Council has accepted the tender of Messrs. Allen and Co. for the erection of the electric lighting station buildings for the sum of £3,656.

Electric Lighting Bills.—The following Bills passed through Committee of the House of Commons on Monday: Electric Lighting Provisional Order (No. 1) Bill; Electric Lighting Provisional Orders (No. 3) Bill.

Western and Brazilian Telegraph Company.—The receipts of the Western and Brazilian Telegraph Company for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,438.

Direct United States Cable Company. — A branch station has been established in Winchester House by the Direct United States Cable Company for the transmission of messages to and from North and South America.

Salford.—The report of the Gas Committee states that they have advertised for tenders for the buildings, engines and machinery, mains, etc., for the electric light installation, and that work will be commenced in a few weeks.

Aberdeen Co-operative Stores.—The directors of the Northern Co-operative Company have agreed to introduce the electric light into the central premises in Loch-street, and it was remitted to the Buildings Committee to have the scheme carried into effect.

Newark.—At the meeting of the Newark Local Board last week the promoters of the scheme for the electric lighting of the borough applied for permission to obtain a provisional order for the commencing of their scheme. This was referred to a committee.

Darlington.—The King's Head Hotel at Darlington, a palatial establishment, and one of the most commodious and ornate hotels in the northern counties, was opened last week with some ceremony. The buildings cost £50,000, and is lighted throughout by electric light.

City and South London Railway Company.—The receipts for the week ending June 4 were £914, against £782 for the same period last year, or an increase of £132. The total receipts for 1893 show an increase of £1,624 over those for the corresponding period of 1892.

Electroplating.—The Edison and Swan United Electric Light Company, Limited, announce that they are now able to undertake at their works in London silver-plating, nickel-plating, and gilding, and are prepared to do such work in quantity at lowest prices compatible with good workmanship and quality.

Powderhall.—The Edinburgh Town Council have agreed, on the recommendation of the Cleaning and Lighting Committee, to accept the estimate of M'Culloch, Sons, and Kennedy, Kilmarnock, amounting to £354. 18s. 1d., for the installation of the electric light at the Powderhall refuse-disposal works.

Worcester Workhouse.—The Corporation propose to supply electricity to the new workhouse buildings, but the wiring of the new buildings will be carried out by the Worcester Guardians. Their clerk is Mr. A. W. Knott, Foregate-street, Worcester. It has been decided by the Worcester Board of Guardians to advertise for tenders.

Hackney.—The Electric Lighting Committee of the Hackney District Board have issued parliamentary notices and plans, and have submitted to the Board of Trade a draft provisional order and schedule showing the list of streets and the area of supply. The draft order approved by the Board of Trade has been included in the Bill which is now in the House of Lords.

Blackburn.—At the last meeting of the Blackburn Town Council the town clerk reported to the Gas Committee that the Local Government Board had given their consent to the borrowing of £50,000 for electric lighting purposes, and it was resolved that the borough engineer and Mr. Barton prepare specifications and working drawings to enable the Corporation to obtain tenders for carrying out the work.

Electric and General Investment. — The Directors have resolved, subject to the completion of the audit, to recommend the payment on July 1 next of the following dividends: On the ordinary shares at the rate of 30 per cent. per annum on the capital paid up for the six months ended May 31 last, making, with the interim dividend already paid, 25 per cent. for the year; and on the founders' shares £30 per share.

French Elmore.—In the matter of Elmore's French Patent Copper Depositing Company, Limited, Mr. Justice Vaughan Williams on Wednesday pronounced a compulsory winding-up order, but subsequently, it appearing that the petition had been made in the belief that it was unopposed, his Lordship withdrew the order, and directed the petition to stand over, with a view to arrangements said to be for the benefit of the creditors.

Sunderland.—Prof. Kennedy has reported on the electric lighting of the town. He estimates that not more than 6d. per unit can be charged, and that at this rate an income of £2,500 would be obtained. The generating plant would cost £17,500, but an additional £3,500 would permit a supply to the shipyards and docks. The estimate is that on a capital outlay of £20,000 the interest and sinking fund of 5¼ per cent. would amount to £1,050 per year, or 2·5d. per unit, leaving 3·5d. per unit sold for working expenses.

Lancaster.—The Town Council have decided to engage an experienced electrician to act as a resident electrical engineer under the direction of the borough surveyor, the commencing salary being fixed at £120 per annum. The committee having charge of the matter are only waiting for the sanction of the Local Government Board to the borrowing of the requisite money to proceed with the works. The differences between the committee and the Brush Electric Lighting Company have been settled.

Derby.—The Lighting Committee report that the Railway Company's Bill provides for the supply of electric light by the company for their own works. Also that the tender of Messrs. Siemens Bros. and Co. for providing and laying mains, ways, etc., with all accessories in connection with supplying electric light (the town supply) have been accepted, and some contracts are proceeding satisfactorily. The committee have fixed the price of incandescent lighting to private consumers at 6d. per Board of Trade unit. The report was accepted.

Bury.—The Corporation of Bury invite tenders, to be accompanied with specifications and reports, for the necessary plant, distributing mains, machinery, and incidental works required for the supply of electricity within the borough. Explanatory plans, conditions of tendering, and particulars, may be obtained from Mr. J. Cartwright, borough engineer, on payment of £2, which sum will be returned after receipt of a bona fide tender within the specified time Tenders, endorsed "Electric Lighting," to be forwarded to the Borough Engineer by July 15.

Stockport.—The surveyor's report for the borough of Stockport just issued mentions the provisional order granted by the Board of Trade for supply of electrical energy to the whole of the borough in March, 1891. Supply to the following portions of the town is obligatory: St. Petersgate Bridge (from the north side of Little Underbank to Market-place); Little Underbank, the Market-place, Lower Hillgate, Great Underbank, Bridge-street, and Heaton-lane (from Bridge-street to Brook-street). The expenses incurred in promotion of order were £283. 13s. 6d.

Richmond.—We hear, says the *Richmond and Twickenham Times*, that the electric lighting contractor for the Richmond Town Hall has secured a site for the plant next the Borough Bicycle Works, in Castle-yard Mr. Shoolbred, the electrical engineer consulted by the Town Council with reference to the town electric lighting works, has considerably astonished his committee by sending in a bill for £240 for services rendered during the past 12 months. This is in addition to the retaining fee of 50 guineas paid a year or so ago. In addition to the bill, he has sent in his resignation.

Fielding Gas-Engines.—The Fielding gas-engine seems popular according to the list of those who use them, or the catalogue of Messrs. Fielding and Platt, of Gloucester. Fielding's self-starter for large engines is guaranteed to start against two-thirds the full load, and this starter can be fitted to engines of any make. The catalogue shows gas-engines, single or twin, indicating up to 200 i.h.p. The consumption of gas guaranteed is very economical. The engine is constructed on the Otto cycle, and is of high-class workmanship. This engine was awarded a gold medal at the Edinburgh exhibition.

Worcester.—The Council of the city of Worcester invite tenders for the erection of their electric lighting station and buildings at Powick Mills, near Worcester. The drawings and specification can be seen and bill of quantities obtained at the town offices, Guildhall, on and after the 19th inst., on payment of £5, which will be returned on receipt of a *bonâ fide* tender. The contract to be entered into by the person whose tender is accepted will contain the clause adopted by the Council as to the standard rate of wages. Tenders must be delivered to Mr. S. G. Purchas, M.I.C.E., Guildhall, Worcester, on or before the 24th inst.

Halifax.—Plans and estimates of the proposed electric lighting works and buildings have been approved at the Gasworks Committee meeting, and ordered to be forwarded to the Local Government Board. The town clerk was instructed to obtain the assent of the Board of Trade to the proposed system for electric lighting within the borough. It was also resolved to invite tenders for the work in connection with the supplying and laying of a system of underground mains, pipes, etc., and the electrical engineer was instructed to prepare plans and specifications of dynamos, engines, and plant required in connection with the proposed system.

Aberdeen.—The Gas Committee of Aberdeen Town Council on Monday recommended the appointment of an electrical engineer, to be responsible to the Council, at a salary of £200 per annum. This was met by an amendment to the effect that the electrical engineer be under the superintendence of the gas manager. It was argued, on the one side, that dual control had not been a success in Glasgow and elsewhere, and, on the other hand, it was contended that as gas-lighting and electricity were opposing interests, it would be unwise to put them under the care of one man. On a division, however, it was decided that the electrical engineer should be put under the gas manager.

South Staffordshire Tramways.—After a very stormy meeting of the South Staffordshire Tramways Company (adjourned annual meeting) on Thursday last week, it was agreed "that the directors and committee be requested to confer with a view to the selection of six shareholders to investigate the affairs of the company, and to report to a further meeting." The chairman, counting those only who were in the room, decided that this was carried by 25 to 11. Some of the shareholders demanded a poll, and on being refused, threatened to appeal to the court. Afterwards it was further agreed that the meeting should stand adjourned till that day eight weeks, at the Grand Hotel, Birmingham, at one o'clock.

Newport.—At the monthly meeting of the Newport City Council Alderman Davies brought up a report of the Parliamentary Committee, which referred to the steps which the committee were taking to provide electric lighting for the borough. He stated that Prof. Robinson had sent in an amended estimate which was £5,000 lower. The high-pressure system was, however, much more reasonable, and made a saving, one of £20,000, and the other of £10,000, over estimated cost for supply at low pressure. The provisional order expired this year, but the committee would take steps to secure the lighting being retained in the hands of the Corporation. The action of the committee was endorsed by the Corporation.

Portsmouth.—Tenders are invited for supply and erection of certain electric cables, both high and low tension conduits, feeding-boxes, etc., for the Portsmouth Urban Sanitary Authority. Copies of specification and plan and form of tender can be obtained on application to Mr. A. Hellard, town clerk, Town Hall, Portsmouth, on or after 5th inst., and on payment of £5. 5s., which will be returned on receipt of a *bonâ fide* tender, and all further particulars can be obtained on application to Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders, on the forms supplied, with the priced bills of quantities attached to the specification, filled in and completed, to be delivered to the town clerk by 10 a.m. on 23rd inst.

Ealing.—The following are the tenders received for supply of boilers for electric lighting, for the Ealing Local Board:

H. and T. Danks	£1,350
Hawksley, Wild, and Co.	2,650
J. Cochrane	2,200
Tinckers, Limited	2,200
Galloways, Limited	2,660
Fletcher and Co.	2,161
J. Watt and Co. (accepted)	1,875
Easton and Anderson, Limited	2,364
Penman and Co.	2,050
S. Hodge and Sons	2,175
J. Thompson	2,450

Bolton.—At the Bolton Town Council meeting on Wednesday a discussion took place with regard to the proposed electric lighting scheme, which is to cost £40,000. Councillor Tootill accused the committee having the matter in hand with delay, laying the greater part of the blame, however, on Alderman Broughton, the vice-chairman. Alderman Miles, chairman of the Gas Committee, assured the Council that there had been no neglect on the part of the Electric Lighting Sub-Committee. Since the adoption of a report on the scheme they had engaged an electrical engineer, and several matters had had to be reconsidered, and a second visit was paid to Oxford to see the installation there. The final report of the committee was ready, and immediately on its adoption by the general body the work would be pushed on with all possible speed. He believed that before the winter was over they would be in a position to supply the electric light to the public.

Bazaar-Lighting.—The electric lighting of the main building of the Royal United Service Institution, at which a bazaar has been opened this week, as well as of the temporary premises and marquees, has been carried out to the plans and specifications of Mr. E. Wingfield Bowles, C.E., the consulting engineer, by the General Electric Power and Traction Company. The main hall is lighted by four large pendants suspended from the ceiling, each carrying five 100-c p. lamps. There are also 14 small pendants suspended under the gallery, each carrying three lights. On the gallery itself there are fixed 16 brass standards, placed at suitable intervals, and each carrying three lights. The total actual candle-power illuminating the main hall amounts to 3,540 c.p. In the crypt, below the main hall, there are three rows of suspended lights, each carrying seven lamps of 32 c.p. For the temporary lighting of the marquees, tents, etc., about 250 16-c.p. lamps are used.

Madras Tramway.—The Madras Electric Tramway Company has not yet decided upon any particular method of electric traction. The overhead wire system, which was at first thought the best, offers difficulties in connection with the local telegraph lines, which it will be costly to overcome. Possibly, therefore, the accumulator system will be adopted, such as has been adopted in Birmingham. Recent improvements have reduced the weight of the accumulators from two tons to half a ton, so that objection on the score of bulkiness will no longer hold good. The *Madras Mail* learns that the company is positive of being able to commence running cars by January 1 next. Before that date it is expected that some scheme for a local directorate will be devised; otherwise the shareholders who have subscribed some £50,000 in India will have a very poor voice in the management of the concern. Later information states that the company have decided to adopt the conduit in lieu of the overhead wire system as being, in the opinion of the best experts at home, the better method of traction. The question of an Indian directorate is now under the consideration of the board of directors.

Johannesberg.—Electric light installations are becoming more sought after in Johannesberg as the town advances. Many of the gold-mining companies have motors for pumping. Both theatres are lighted, and there is a town-lighting company, but the town committee does not take full advantage as yet, the chief service being for shops and private houses. But the town being only five years old, the progress achieved may be considered one of the marvels of the age. One of our correspondents in Johannesberg, Mr. G. A. Stanton, has been appointed electrical engineer to the Ferreira Gold-Mining Company, one of the largest on the Rand, about to be amalgamated with the Wemmer Gold-Mining Company. At present there is only a 10-unit machine on the property, but extra plant and motors are being sent out. Where there are no vested interests in gas or steam engines to overcome, and plenty of work to be done, as in such colonial towns, there is a fine field for electrical plant.

Three-Wire Patent.—We understand that all the principal corporations and companies which have put down installations on the three-wire system with batteries are now making contracts with the Westinghouse Electric Company, who are the owners of the patents. The royalty charged is the moderate one of £2. 10s. per ton per annum during the life of the patent. The Corporations of Dundee, Glasgow, and Hull, and many of the companies who use batteries, have signed contracts. They have been induced to agree to pay the royalty rather than question the right to charge for the three-wire patent on other than direct working, by the very moderate royalty asked. Broadly speaking, for every 100 tons of copper required in a parallel distribution, only 30 tons will be required on the three-wire system; the saving is therefore 70 tons at the present price of copper, and the royalty asked is practically less than 2 per cent. per year on the actual saving in cost of copper. The company might of course have charged on the saving of copper, by which they would in most cases have obtained higher royalties, but, as is natural, the weight of copper used is easier of recognition than that which is not used, so that the present method may be considered preferable.

Croydon Barracks.—A great improvement has recently been made at the Croydon Barracks, in the Mitcham-road, in the shape of an installation of electric light for the drill ground and shed. Four arc lamps have been fixed in the parade ground and one in the drill-shed, with a view of obtaining the advantage of being able to practice battalion movements in the dark evenings without being confined to the small space afforded by the drill-shed, which has hitherto been the only available space for the purpose. The motive power is supplied by a 6-h.p. gas-engine, which, applied to a series-wound dynamo, gives an output of 3,000 watts. The current is distributed through overhead wires to the lamps, which are suspended from poles at a distance of 20ft. from the ground. The light derived from these lamps is equal to 2,000 c p., and thoroughly illuminates the ground, giving the drill instructors and officers ample opportunity of seeing what the men are about. The arc lights are exceedingly steady, and there is an entire absence from flickering, a fact which speaks well for the manner in which the installation has been carried out. It is worthy of notice that the battalion had not to go out of their own ranks to find an electrician to instal the electric light, for the work has been done by Mr. W. J. Bishop, of 74, George-street, who is a colour-sergeant in the battalion, and has carried out the installation in a very successful manner.

Manchester Telephones.—At a meeting of the Manchester City Council, held on Wednesday, a report was presented from the Paving, Sewering, and Highways Committee in reference to an application of the National Telephone Company to place wires under certain streets of the city. Correspondence has been passing between the town clerk, the city surveyor, and the general manager of the company on the subject. In one of his communications to the town clerk, the manager of the company states that the company have determined to reconstruct and rearrange an extensive portion of their Manchester system, with a view to ensuring to Manchester the greatest efficiency in its telephone service. This work is in progress, and the question for the determination of the Corporation is whether they would prefer a large proportion of the wires in the central parts of the city being placed underground, and will give facilities for that to be done, or whether they would prefer that the company should proceed as heretofore by means of overhead wires. If the company's suggestions are accepted, three-fourths of the wires which are at present overhead in the central parts of the city will be removed and placed underground. The company propose to place the wires in 3in. iron tubes, each tube to contain 100 subscribers' lines, the tubes to be properly braced together, and the work to be done to the satisfaction of the Corporation.

Proposed Electric Tramways for Halifax.—Mr. J. B. Holroyd, of Halifax, has written to the Board of Works Committee of the Halifax Corporation, on behalf of a number of gentlemen who are prepared, entirely at their own cost, to lay down a system of electric tramways on the overhead trolley system, and to fit up, equip, and work the same in the borough of Halifax, provided the Corporation will grant the promoters the sole right to work and use the same without being subject to any charge for a term of 21 years. At the expiration o fthat period, if the Corporation chooses to take over the undertaking and to carry it on, it shall be at liberty to do so on paying to the promoters a valuation for the plant. Should the Corporation not wish to take the plant, then the promoters shall have a monopoly for a further term of 21 years; but should neither party wish to carry on the business, then the promoters will take up and remove the entire tramway plant, and at their expense restore the streets to their former state. The routes to be taken by the tramway lines and the scale of charges to take from the passengers are to be settled between the Corporation and the promoters before the commencement of the work. Mr. Holroyd states that the promoters are wishful to erect the system in a locality where the difficulties arising from the gradients are more than ordinary, as in Halifax. The committee appointed a sub-committee to go into the matter and report at a future meeting.

Canada.—About 70 miles of electric railway will be laid round Toronto, according to the *Canadian Engineer*, this summer. Toronto has the best electric car service in Canada, if not in the States. By autumn, Toronto will have 128 miles of track and 530 cars. An electric railway, we also learn, superintended by Mr. Keating, of Toronto, will be run from Hamilton to Guelph. The Edison Company are to build an electric railway in Hamilton, Ontario. Cars began running at Brantford in April, and the first electric car ran in St. John, N.B., at the same time. A scheme for an electric railway from Nanaimo to Wellington, British Columbia, is started, and another from Lulu Island to Westminster in the same district. The town of Niagara, Ontario, has just been lighted by electricity, and an electric car line will run from St. Catherine's to Niagara Falls. Fredericton, N.B., will have an electric line, four or five miles, to Marysville, crossing the river by a light steel bridge. The Montreal street railway is to be changed to an electric road, at the cost of 3,000,000dol., by Ross and Mckenzie, the contractors. The Montreal Electric Company has opened operations as manufacturers and dealers at 302, St. James-street, Montreal, and Henderson and Co., Bleury-street, in the same town, do construction work. The Kay Electric Company, of Hamilton, make excellent motors, under their manager, Mr. Douglas. An electric railway is planned for Hamilton. Electrical work seems busy in Canada.

Durham.—Mr. Henry Lyon, writing from Barcelona to the *Durham County Advertiser* with reference to the formation of an electric light company at Durham, says: "I suggested this some years ago, and the matter fell through. As you know, I am a native of Durham, and take a deep interest in the affairs of that ancient city. I am the chief electrical engineer to this company (Sociedad Espanola de Electricidad), and have a plant of close upon 3,000 h.p. under my charge. Therefore a little advice may serve a good purpose, and save any stumbling. Durham is not like other large towns that can make use of all the advantages of electricity, therefore the scope of lighting the public streets and private customers is one that only could be looked forward to to provide a decent income. You must consider the Act of Parliament and the provisional order and the Board of Trade rules. The Town Council have the first power, if they choose to make use of same, to supply the electric light. This, in my opinion, would be more beneficial to the public of the city of Durham, as all would enjoy the benefits of the new illumination at a lower rate, and the profits would assist to reduce the rates and taxes. The River Wear has a good quantity of water running to waste, but not more than 200 h.p. at most, and this only when the water is at its best. Then there are times when the river swells, and the fall is practically broken. To utilise the water power would entail a larger outlay of capital than a new steam plant placed in a more central position to furnish the heaviest supply, the power at the Old Mill not being enough to work the whole plant without a reserve of accumulators, and therefore an additional capital outlay, and the system being different, would be more expensive to maintain. There is no difficulty in getting coal in Durham. Here we have to pay £2 a ton, and have to pay for water for boilers at ¼d. per nine cubic feet, and we sell our electric light at 10d. per unit. Therefore, I would advise a system of engines, boilers, dynamos, etc., for 6,000 lamps, with a reserve of about 2,000 lamps, the cost of which would be about £14,000, without buildings." Mr. Lyon adds that if there is anything he could do to forward the interests of the city of Durham, he would be most happy to do so, even to the extent of taking shares in the proposed company.

Belfast.—An installation of the electric light is being erected for the Queen's Quay, Belfast. The generating station is to be on the Queen's-road. The piling for the foundations has been practically completed, and the erection of the necessary buildings will be proceeded with at once. The engines to be used are fitted with patent Corliss valves, and, together with the boiler, will be supplied and fixed by Messrs. Combe, Barbour, and Combe. The plant is of sufficient power to drive double the number of dynamos which will be put down at present. Siemens dynamos and lamps will be used. The area of lighting is from the Queen's Bridge along the quay, round the Abercorn Basin, and on both sides of the Hamilton Graving Dock. Thirty-one arc lamps are to be erected. The lamps will be 50 yards apart, and the posts, which are of iron lattice-work on cast-iron bases, are 40ft. high. Overhead lines will be put up, steel conductors being used instead of the usual copper. A double circuit has been provided for, each alternate lamp being on a separate circuit, thus preventing total darkness in case of any failure of the light, and allowing either half of the lamps to be put out as may be required. Some difficulty was experienced in fixing the positions of the lamps not to interfere with the traffic, and yet to obtain maximum effect. Mr. George Combe, electrical engineer, of 3, High-street, Belfast, has been consulted and, in conjunction with the Harbour Commissioners' engineers, Mr. Giles and Mr. Kelly, has fixed the positions of the lamps in the most suitable places that could be found. In addition to the lighting of the quay, the Harbour Commissioners propose to put down at a future time an underground circuit, in order to supply incandescent lights on hire to any vessel desiring to use the same during the discharge of cargo. This will be of great benefit to the men working in the holds of vessels, and will do away with the danger always present when ordinary oil lamps are used. Arrangements have been made in the engine-house to allow the extra machinery necessary for this purpose being put down. The engine-house and station is being erected by the Harbour Commissioners under the superintendence of their own engineers, Mr. Giles and Mr. Kelly, and Mr. G. Combe has charge of the electrical part of the work. It is expected that the whole work will be completed and the station in full working order within two months.

Southport.—At a special meeting of the Southport Town Council convened last week for the purpose of further considering the electric lighting scheme, Alderman Hacking proposed that an electrical installation be put down in the town area. He stated that the estimated cost was £28,000, and that the borrowing powers provided for repayment in 25 years. The scheme included the lighting of what was scheduled, the town area and the outside portions of the township. It was now found, after going to considerable expense, that £2,000 more than originally estimated would be required. The yearly expenditure would be £3,581, including £1,608 for capital charges and £1,873 for working expenses, whilst the income would amount to £1,425, leaving a deficiency of £2,156. He proposed that they should bring forward another scheme for the lighting of a smaller town area only. Councillor Hodge seconded. It was explained that the scheme was intended to reduce the expenditure from £28,000 to £12,000. Alderman Griffiths moved as an amendment that the scheme of the electrical engineer passed by the committee in August, 1892, and adopted by the Council in October, 1892, and further emphatically endorsed by the electrical expert, Mr. Manville, be carried out forthwith, but that it be optional with the Council to carry out the whole of the works, or only that portion necessary for lighting the town area. He strongly condemned the action of Alderman Hacking, the chairman of the Electric Lighting Committee, in bringing forward a scheme which had never been considered by the committee, and which was in direct opposition to the opinions of the electrical experts. If there could be a wasteful, extravagant, blundering, and muddling scheme, is would be the one proposed by Alderman Hacking to put down an installation in the town area only. No member of the Council could argue that it would be a feasible step to adopt, because no small installation had ever been a success. The scheme originally proposed was stated by electrical engineers in the country to be one of the best that had ever been put before the electrical world. There had been already £2,000 expended in investigations, and he strongly objected to only the town area being supplied, which was not one-half the full area, and yet at a cost of one-half the original estimate. He suggested that a scheme could be adopted by which they could supply both areas at a cost of £18,000 with the high-tension system. Councillor Watson seconded the amendment. Several members confessed to not understanding the scheme. Councillor Travis said the committee wanted to know if they were to proceed with the town area only or with the full area. When they had that question decided they should bring the matter forward with full details. Councillor Robson supported the amendment, and Councillor Pilling characterised the action of the committee in bringing forward such a resolution as degrading and dishonourable. He felt inclined to move that the committee be dissolved. Councillor Karr said he would have seconded such a proposition had it been moved. The amendment was finally lost by 18 votes to 15. Councillor Threlfall then moved another amendment to refer the matter back to the committee for fuller information from the engineer, including the comparative cost of supplying an area from Crowlands (the gasworks) to Eastbank-street respectively and the yearly cost of maintenance. This amendment was, however, lost, and another amendment was moved by Alderman Griffiths amidst considerable disorder, and eventually it was resolved that an electrical installation be put down for the town area, and that the committee be instructed to bring up a statement by the electrical engineer as to the comparative cost and comparative advantages and disadvantages to light the town area from Crowlands to the town site, having regard both to capital and working expenses. After a discussion occupying four hours and a quarter, the proceedings of the Council then terminated.

PROVISIONAL PATENTS, 1893.

MAY 29.

10474. **Improvements in the construction and form of accumulators for the storage of electrical energy.** John Shell Bolton and Thomas John Murday, 55, Northbourne-street, Gateshead-on-Tyne.

10501. **Improved method of heating liquids by electricity.** Charles Henry Prichard, 9, Warwick-court, Gray's-inn, London. (Complete specification).

MAY 30.

10533. **Improvements in electrical signalling and printing telegraph systems and in apparatus employed therein.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Alfred Samuel McCaskey, United States). (Complete specification.)

10584. **Improvements in connection with electrolytic apparatus.** Hamilton Young Castner, 55, Chancery-lane, London.

10569. **Improvements in means or apparatus for regulating the temperature of electrical heating, cooking, or like apparatus.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery-lane, London.

10594. **A novel method of ornamenting or decorating the bulbs of incandescent electric lamps.** Thomas Brooks Browne, 20, High Holborn, London.

10597. **Improvements in devices for adapting electric lamps to ordinary candle fittings and the like.** George Sidney Sluce, 20, High Holborn, London.

10615. **Improvements in telephony or means for transmitting telephonic signals through long distances.** Joseph Hines, 6, Lord-street, Liverpool.

10623. **Improvements in printing telegraphs.** Donald Murray, 53, Chancery-lane, London.

10630. **An improved material or combination of materials to be used for the manufacture of electric arc candles, applicable also for the manufacture of brushes or collectors of dynamos or electric motors.** Thomas Oddy, 9, Warwick-court, Gray's-inn, London.

MAY 31.

10648. **An improved combined electric light and heat stove.** George Mitchell, 47, Victoria-street, Westminster, London.

10696. **Improvements in insulators for electric wires.** Henry Harris Lake, 45 Southampton-buildings, Chancery-lane London. (Eugen Hartmann and Wunibald Braun Germany.)

JUNE 1.

10720. **Driving tricycles and other similar vehicles by electricity.** Anthony Matuszkiewicz, 9, Westland-row, Dublin.

10765. **Improvements in secondary voltaic batteries.** Ernest John Clubbe and Alfred William Southey, 53, Chancery-lane, London.

10772. **Improvements in ceiling roses for electric connections.** George Hawkins Cutting, 77, Chancery-lane, London.

JUNE 2.

10788. **Improvements in the arrangement of stations for the generation of electricity.** The Hon. Charles Algernon Parsons, 13, Temple-street, Birmingham.

10821. **Improvement in or relating to the regulations of electric currents.** Wilfrid Swanwick Boult, Cedric Randal Boult, and Francis Gibson Baily, 323, High Holborn, London.

10830. **Improvements in electric storage batteries.** Ernest Bailey and George Mortimer Gordon, Broad street House, London.

10843. **Improvements in or connected with electric railways and tramways.** Jean Claret and Olivier Wuilleumier, 47, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1892.

9566. **Electric percussive tools.** Atkinson.

10632. **Electric switches.** Brain.

11664. **Electric conductors.** Payne.

12735. **Telegraph insulators.** J. C. and G. Fuller.

12807. **Electric arc lamps.** Money and Nash.

12906. **Electrical connections for ceilings.** Haddow and Hutchison.

13595. **Electric currents.** Ewing and Lamb.

1893.

2586. **Diaphragm for electrolytic cells.** Waite.

4489. **Electric fire alarms.** Krogh.

6468. **Electric arc lamps.** Siemens Bros. and Co., Limited, and Nebel.

6702. **Dynamo brushes.** Koch.

6952. **Electrically-heated crucibles.** Mitchell.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅝
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	6¼ 4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5⅛
St. James'	—	8¼
Swan United	3½	3⅛
Westminster Electric	—	5¾

NOTES.

Sunderland.—The provisional order for Sunderland expires this month.

Niagara.—A company is being formed, it is stated, for the distribution of power from Niagara throughout New York.

American Institute.—Prof. Houston is the new president of the American Institution of Electrical Engineers.

Marseilles Tramways.—The description of the new electric railway at Marseilles is commenced in the last number of *Electricité*.

Transformers.—An interesting paper on early types of transformers, with illustrations, is given in *Cosmos* (June 3) by M. de Contades.

Industrial Electricity.—A two-volume book, under the title of "L'Electricité Industrielle," by M. P. Minel, is published by MM. Gauthier-Villars, of Paris.

Royal Meteorological Society.—On Wednesday, the 21st inst., Mr. E. D. Archibald will lecture on "Australian Climate," illustrated by lantern slides.

Electric Traction in Paris.—Electrical engineers visiting Paris will be able to see the service of electric trains now started between the Place de L'Opéra and St.-Denis.

Gotha.—The contract for a central station at Gotha, to the amount of £30,000, has been awarded to Messrs. Lahmeyer and Co., of Frankfort. An electric tramway, costing over £5,000, will be also established at the same time.

Transformation.—At Ottawa the interesting experiment (it is nothing more) is shown of electricity generated by water power being used to generate steam in an electrically-heated boiler, which is again used to drive an engine.

Electric Tachometer.—An electric instrument for recording the speed of rotation of ships' shafts has been brought out by Messrs. Siemens and Halske. It is illustrated and described in the *Elektrotechnische Zeitschrift* of the 9th inst.

Chicago.—Papers on electrical subjects for the Chicago Exhibition should be sent to Prof. T. C. Mendenhall, Washington, D.C., not later than August 1. Electrical standards and units will be considered by a special body, as already announced.

Traction in Milan.—The Societa Anonima degli Omnibus is making trials with accumulator cars on the line from Milan to Monza, a distance traversed in half-an-hour. The trials were satisfactory, and it is said that the motor car is capable of hauling two or three ordinary cars.

Death of a Pioneer.—At the age of 73, Prof. Moses G. Farmer, the veteran pioneer electrician, has died in Chicago from a cold. He was the inventor of fire-alarm apparatus controlled by electricity, and built in 1847 an electromagnetic engine for railroad at Dover, New Hampshire, run by 48 Grove cells.

Trolley System in France.—In addition to transforming the existing tramway at Havre into the Thomson-Houston system, as mentioned in a previous issue, the French company working these patents are to electrically equip the tram lines at Lyons and at Bordeaux. The lines are to be in operation towards the close of the year.

Electric Rocking-Chair.—This is the description of the latest novelty going the rounds: An electrical rocking-chair has been brought out by Mr. C. E. Hartelins, of Bay Ridge, New York. The chair is actuated by the current from a dynamo, and the sitter can at the same time receive gentle currents through the body either by grasping metal handles in the ordinary way, or by resting the bare feet on metal pedals.

Water Power.—The waterfalls at Rheinfelden, owned jointly by the cantons of Aarau and Baden, and ranging from 15,000 h.p. in the upper reaches to 8,000 h.p. in the lower reaches, are to be used for the electrical transmission of power. Part of this power will be utilised by the Neuhausen Aluminium Company in extending the production of aluminium, whilst the remainder will be devoted to general industrial purposes. A powerful syndicate has been formed to carry out the latter object.

Corridor Train.—The Great Western Railway Company have commenced running a new "corridor train" between London and Penzance. It is composed of four coaches—a first and third composite, a brake second, a brake third, and a third, each 56ft. long, so that the entire length of the train, exclusive of engine, etc., is 224ft. The compartments will be heated when necessary by means of steam, and electric communication is provided. The train will run from Paddington to Penzance in a little more than eight hours.

Conversazione.—The annual conversazione of the Institution of Electrical Engineers will be held on Friday, the 23rd inst. Members and their friends will be received by the President (Mr. W. H. Preece, F.R.S.), and Miss Preece in the galleries of the Royal Institute of Painters in Water Colours, 191, Piccadilly. We are requested to state that as the hat and coat accommodation is very limited at the galleries of the Institution of Painters in Water Colours, it will be very desirable that gentlemen attending the President's soirée on should bring either crush or felt hats.

Suez Canal.—The directors of the Suez Canal at their annual meeting last week in Paris, have made an alteration as to the conditions of using electric light. Ships can now pass each other in the widened portions of the canal, so that vessels stopping suffer only slight delay, and, in order to reduce this to a minimum, the Board has made it compulsory from October 1 next for vessels passing at night to use an apparatus dividing the light from their electric projector into two divergent streams. By this means vessels advancing in opposite directions will be able to continue on their course without being dazzled by each other's electric lights.

Milan.—The town of Milan is one of the most advanced in the employment of electricity. Long having an admirable public lighting system, it is now being equipped with the Thomson-Houston trolley tramway. This will be 3½ miles long, the cars to carry 40 passengers, the pressure being 500 volts. The gross receipts for electric lighting in Milan reached in 1892 the sum of 1,116,527f., an increase of 50,000f. over the previous year, with a diminution of expenditure of 52,000f., and a total net profit of 300,000f. The lighting now comprises 25,500 incandescents and 900 arc lamps. The electricity is produced for the consumption of 11·88lb. of Cardiff coal per kilowatt-hour.

Electric Tempering.—M. Lippmann has brought to the notice of the French Academy of Sciences a new system of tempering metals devised by M. Lagrange, who is a captain in the Belgian army, and professor at the Brussels Military School. M. Lagrange places the piece of metal to be tempered, a piece of steel, for instance, in a vessel containing acidulated water. He makes use of it as an electrode, and causes a current of electricity to be passe The piece then glows, and is heated; it is then w before fusion, and is plunged in a cold liquid thus obtained is only superficial, but it is said that it may be serviceable for certain industrial applications.

Windermere.—The site of that romantic spot known as Fell's bobbin mill at Troutbeck Bridge, Windermere, has been utilised as an electric lighting station. The old waterwheel, over which the pearly drops used to be flung on bank and fern, has given place to a turbine. A Galloway boiler and Armington-Sims engine are also installed, and drive a Mordey alternator. About 650 lamps are now supplied, and the Windermere hotels are lighted. As soon as arrangements can be made, all the public lamps within the Bowness Local Board district will also be lighted. Harnessing the waters at the lakes has begun, and perhaps the water will "come down at Lodore" to lightful purpose, some day.

Switzerland.—The following statistics of electric installations in Switzerland are given in a report by Prof. Dentzler, of the Polytechnikum, Zurich, Company, 1890 and 1892:

	1890.	1892.
Lighting installations	434	562
Transmission of power	33	53
Batteries of accumulators	73	121
Dynamos and motors	712	1,056
Total capacity in kilowatts	13,044	20,623
Incandescent lamps	68,368	115,926
Arc lamps	1,068	1,746

The capital invested is estimated at 12,700,000f., without reckoning engines or turbines. Seven new electrical manufacturing firms are added to the 31 existing in 1890.

Accumulator Monopoly in France.—The decree pronounced by the Paris Court of Appeal last month in the matter of the Société Française des Accumulateurs has, according to a writer in *L'Electricien*, produced considerable excitement in electrical circles. The judgment was in favour of this company, and declared as infringers of four Faure patents all makers who employed salts or oxides of lead in the manufacture of accumulators. It is asserted that the consequences of this decision will be serious in the sense that judgment was given contrary to the report of the experts and against the advice of the Public Ministry. It is urged that the effect of this decision is to monopolise the manufacture of secondary batteries in France, and that makers are liable to prosecution even if they employ methods of manufacture different to those of Faure.

Water-Pipes.—A correspondent of the *Génie Civil* finds that there is always a small current, appreciable as a crackling in a telephone, between the gas and water pipes in the same house, the negative being the gas-pipe. The writer attributes these currents to slow chemical change. The observations, however, suggested that there was considerable insulation resistance between the pipes, and that they might act as telephonic conductors. He succeeded in carrying on a conversation between two houses 100 yards away without other conductor. A microphone without induction coil was joined to three bichromate cells. To find out if the experiment will succeed, all that is necessary is to set a small induction coil to work, and on joining a telephone to the pipes in the neighbourhood the sound is heard if connection is good. If not good enough for speech, Morse signals can be transmitted.

"Industries" and "Iron."—With this week comes a change in the management of two of our contemporaries—*Industries* and *Iron*. Hitherto owned by two companies, they are now established under new management, having been purchased by Mr. Pearson, of a well-known weekly, and a new company is formed. The joint paper is edited for the present by Mr. Yeaman, late of the Preston Electric Company, who has our best wishes. Mr. Cawley, late editor of *Industries*, is now established as consulting engineer. Mr. Perry F. Nursey, the veteran editor of *Iron*, takes his bow with the last number. Established in 1823, it was carried on for 50 years as the *Mechanics' Magazine*. For five of these years, and for 14 as *Iron*, Mr. Nursey was editor. Two of the directors of Sutherland, Dowson, and Co., the late proprietors, join the board of the new company. Mr. Swinburne still retains his connection with the paper.

Telephones and the Government.—In the House of Commons on Monday, Sir J. Fergusson asked the Postmaster-General what progress had been made under the Telegraph Act, 1892, in the acquisition of the trunk lines of telephones from the companies, in the construction of additional lines, and in the deliminations of the exchanges. Mr. A. Morley said there had been some delay in carrying out the arrangement made by the late Government, owing to the negotiations which were taking place with the telephone companies. Considerable progress had, however, now been made, the establishment of trunk lines would not be long delayed, and progress had been made in the construction of main lines between London and Glasgow and Edinburgh, South Wales, the West of England, and the coal ports of the North. He could hardly hope that these lines would be completed before the end of the financial year.

High Resistances.—The *Journal* gives the following abstract of a paper by Mr. F. J. Smith (*Philosophical Magazine*, No. 214, 1893): "To save the great expense of large wire resistances, used in connection with the D'Arsonval galvanometer, the author has made experiments on non-metallic resistances and mercury jet-contacts, and has found a very reliable resistance to be one made thus: Dry plaster of Paris and electrotype plumbago are intimately mixed in suitable proportions, depending on the resistance required (equal quantities in a tube 0·4cm. diameter and 11·5cm. long measured 65,000 ω), and the mixture is rammed into a glass tube having a platinum terminal; the second terminal is fixed by compression into the material, and the tube is sealed by a blow-pipe. Very finely-powdered glass mixed with plumbago is used for very high resistances, but is not so manageable as plaster. A megohm made thus costs only a few shillings."

Telephones in a Storm.—Dr. H. Bendelack Hewitson, the celebrated Leeds oculist, writes to the editors of the *Leeds Mercury* as follows: "During the recent thunderstorm near Skipton, the attendant at the telephone call office there related to me his experience, which I think ought to be recorded as a warning against the use of the telephone instruments during a thunderstorm over a wide area. Seeing the storm coming, though still at some distance, he went to the telephone for the purpose of acquainting those in charge of the central exchange at Bradford that a storm was approaching, and the instrument would not be available until it was over. The moment he put his ear to the telephone a flash occurred, and he received a blow of such severity that he was sent across the small chamber against the opposite wall. Otherwise, beyond the temporary but very severe shock—which he described as 'a severe box on the ear,' sending him reeling backwards—he was unhurt."

Bristol Exhibition.—The Bristol Corporation will shortly hold an industrial and fine art exhibition, and the Lighting Committee propose to exhibit illuminated electroliers, pendants, and other fittings for the lighting of the fine art section free of charge for current to firms who will lend the fittings. This is being arranged in the interests of the electricity department of the city, so that intending consumers may have better facilities for the selection of their fittings than would otherwise be the case. The exhibition, we are informed by the resident electrical engineer (Mr. H. Faraday Proctor), will be lighted throughout by electricity from the city mains, and electric work in general will be made a feature. The supply of current to the exhibition will commence at the end of August, when the exhibition opens. It is, however, proposed to light the fine art section at an earlier date from a separate plant. The general lighting of the city will be ready in September.

Sayers's Regulating Dynamo.—The interest excited by Mr. Sayers's paper will no doubt lead many engineers to make their own experiments, and we shall doubtless hear further from Mr. Sayers. Meanwhile, it may be interesting to state that the 40-unit armature shown at the Institution was a new one, and has been as yet only run at Messrs. Mavor and Coulson's works for testing purposes. A regulating plant has just been completed for the Midland Railway Company, which is composed of two dynamos which excite without winding on the field magnets. These machines are the widest departure from established practice, and the tests shortly to be made will be of the greatest interest. There is a machine also in use in a Bradford hotel which can be seen at work; this is the machine represented diagrammatically in Fig. 9 of the paper. The regulators mentioned will be at work in the Derby Station of the Midland Railway Company in about two months, and will be the object of much curiosity on the part of engineers.

Telephone Trunk Lines.—The Post Office authorities have commenced to lay down the necessary lines to connect South Wales with Newcastle-on-Tyne, and it is hoped that by the end of the present year or early in 1894 that telephonic service between Cardiff, Newport, and Newcastle will be complete. Gangs of men are already at work strengthening lines and laying on additional wires between Cardiff and Newport and Newport and Chepstow. It is intended to make two circuits, each circuit consisting of two wires from Cardiff to Bristol, and from Bristol, *viâ* Hereford, to Newcastle; the second circuit being from Cardiff to Newcastle, *viâ* Hereford. The work is being carried out in sections, and gangs of men are at work along almost the entire route. The Department is taking special measures to ensure that the new service shall be a success in the matter of hearing. The work at present being carried out is a portion of the scheme which the Department has undertaken to connect all the great industrial centres of the kingdom by telephone, connection of the South Wales ports with Liverpool having recently been completed. The new service when finished cannot fail to be of benefit to the shipping firms of Newport and Cardiff.

Civil Engineer Premiums.—The Institution of Civil Engineers have awarded, among others, the following civil engineer premiums for original communications submitted during the past session: A Telford Medal and a Telford Premium to Peter William Willans, M.I.C.E. (deceased), for his paper on "Steam-Engine Trials"; a George Stephenson Medal and a Telford Premium to Edward Hopkinson, M.A., D.Sc., M.I.C.E., for his paper on "Electrical Railways: the City and South London Railway"; a Watt Medal and a Telford Premium to Herbert Byrom Ransom, A.M.I.C.E., for his paper on "A Method of Testing Engine Governors"; a Telford Premium to Alfred Weeks Szlumper, M.I.C.E., for his paper on "The Signalling at the Waterloo Terminus of the London and South-Western Railway"; a Telford Premium to Charles Sheibner Du Riche Preller, M.A., Ph.D., A.M.I.C·E., for his account of the "Zurich Water Supply, Power, and Electric Works." Also for students' papers: A Miller Prize to Francis Gibson Baily, B.A., Stud.I.C.E., for his paper entitled "Some Points in the Regulation of Direct-Current Motors"; and a Miller Prize to Arthur Shaw Butterworth, Stud.I.C.E., for his paper on "The Disposal of Town Refuse by Burning, and the Application of the Heat thereby Generated."

Ohm's Law Modified.—Mr. Fernando Sanford has determined the resistance of a copper circuit containing various dielectrics, and has come to the conclusion that the resistance depends to an appreciable extent on the dielectric. The copper circuit in his experiments took the form of a double-ended cylinder, having a wire attached to the centre of the lower end and passing through an insulating bush in the upper one. This was filled with various dielectrics, and curves were taken of its resistance at various temperatures over a range of 10deg. C., by a bridge capable of measuring resistances within 0·00001 ohm with a fair degree of accuracy. Air and petroleum were compared by means of series of observations extending over two month, the dielectrics being changed five times, and the results were perfectly consistent. The author found that if the conductivity of the copper in air be taken as unity, its value varies from 1·0018 in petroleum to 0·9973 in a mixture of wood, alcohol, and petroleum—a range of nearly ½ per cent. He finds that it is probable that only the part of the dielectric in direct contact was concerned in the effect, as until it was thoroughly cleaned and dried the cylinder did not return to the value unity. A silver wire shows the same effect to a less marked degree.

Electricity in Agriculture.—The American Department of State has just issued the results of an enquiry, instituted in 1892, on the use of electricity in different parts of the world as a power in the propulsion of farm machinery and implements and in the propagation of plants. Outside the United States experiments have been made in England, Germany, France, and Belgium. The late Sir William Siemens, working at Sherwood with a dynamo, arc lamp, and 3-h.p. Otto gas-engine, established the following conclusions: (1) That electric light is both efficacious in producing chlorophyl in the leaves of plants and in promoting growth; (2) that plants do not require a period of rest during the 24 hours, but make increased and vigorous progress if subjected during the night to electric light; (3) that the light is efficacious in hastening the development of flowers and fruit—the flowers produced by its aid are remarkable for intense colouring and the fruit for bloom and aroma; (4) that the expense depends on the cost of energy, and is moderate when the natural energy of water is available. At the Paris Exhibition the conservatories' electric light was kept burning continually, and it was found the light gave vigour to the flowers; but the expense was great. Attempts have been made to pass electric currents in buckets where seeds were washed preparatory to sowing, in order to kill the invisible microbes; and it has been claimed that the generating power of the seeds is increased. In Belgium and England electric motors are successfully employed for driving thrashing and dairy machines.

Rugby School.—The preliminary arrangements for lighting Rugby School with electricity are now complete, and the work of laying down the generating plant is being proceeded with. The boarding-houses, the sanatorium, the art museum, the gymnasium, and the whole of the school will be fitted up with the light, and about 1,500 incandescent lamps will be used. The dynamo will be placed in Dr. Percival's stable yard at the rear of the gymnasium, and it will be propelled by gas power, for which Dowson's gas, manufactured on the spot, will be used. The gas-engine is of 100 h.p. It works with two impulses each revolution, with the advantage of increased steadiness for electric lighting. As the installation supplies only nine or ten consumers, each with regular and known wants, it will be possible to generate electricity for these boarding-houses at a much cheaper rate than usual—that is to say, at 4d. or 4½d. per Board of Trade unit, which is equivalent to gas at 3s. 6d. per thousand cubic feet. The lighting will be carried out on the co-operative principle, the house masters finding the necessary capital, and supplying themselves with the light as cheaply as possible. It is expected that this will cost less than the existing means of illumination by gas and candles. By the end of August the generating plant will have been laid down, and the necessary wires will be fitted in the houses during the summer holidays, so that when the boys return to school about the middle of September they will find the light in working order. This shows a progressive spirit in the school, which such institutions are not always in England the first to share.

Technical Education.—A significant sign of the times is the serious way in which journals of all classes are taking up the question of technical education. Prof. Thompson's saying that "Technical education must be technical," wants drumming into educationalists and education committees alike. The teaching profession must learn that the intelligent public are not yet content. They do not progress as fast as is wanted. Only the other day we heard an employer actually state that if a candidate for work offered his certificate from Finsbury or South Kensington as inducement, this was put against him and not for him, so much was the assumption of superiority, and the lack of real practical knowledge yet manifest, even in students from the leading schools of this kind. Men who have been through the shops are employed at once, but theoretical students lack intellectual perspective amidst a maze of mathematics and hypothetical theory. In other schools the practical useful efficiency is appallingly low compared to the time expended. A correspondent to *Industries* says craft must be taught by a craftsman. The educationalists say: no, by a teacher. The truth is both are wanted; and we must get them, still more than at present. The country Press often contains articles railing, and rightly, at the so-called technical teaching—useless smatterings of old text-books thrust pell-mell into unprepared minds. London may, if it likes, be at the head of technical training, but for heaven's sake let us have the method of teaching itself constantly examined and ameliorated, so that it may be of the utmost efficiency, and that technical really means technical. Then the expenditure of the two or three years of labour by the students and teachers may be justified by the results outside examinations.

Transforming Direct to Alternating Currents.—Since the introduction of triphase currents, the transformation of continuous currents into triphase, two-phase, or ordinary alternating currents has been effected with facility. Mr. F. Lucas, according to *La Lumière Electrique*, has recently devised a method of transforming a continuous current from any source whatsoever into either simple alternating currents or multiphase currents with any desired frequency. The apparatus consists of two copper or silicon bronze rings, each having an odd number of equally spaced radial arms. These two rings are mounted on the same spindle, and separated from one another by a disc of insulating material, and so fixed that the arms on one side coincide with the spaces on the other. Connections are made in the following manner: The poles of the continuous-current source are connected to brushes making contact with the two rings. The ends of the circuit destined to carry the alternating current are connected to two brushes, each wide enough to make contact on either set of arms alternately, and placed diametrically opposite to one another. It will be seen that neither brush can make contact on both sides simultaneously, since the arms on one side coincide with gaps on the other. It will also be evident that when the top brush is bearing on one side the bottom brush will be bearing on the other side, as each set is made up of an odd number of arms. If the spindle be rotated, an alternating current will be produced, since the brushes alternately make contact on arms of different sign. If $n =$ the number of each set of radial arms, then the number of reversals per revolution $= 2n$. If ω be the angular velocity of the arms, then the duration of each period $= \omega/n$, and is therefore proportional to angular velocity, and inversely proportional to the number of arms. There is, however, a period of short circuit at every reversal, and in order to make this period as short as possible, Mr. Lucas found it necessary to give the brushes a gentle rocking motion. By suitably arranging the brushes it is possible to obtain diphase and triphase currents.

Single-Phase Alternating-Current Motors.—Several of the new and interesting type of single-phase motors were exhibited at the Royal Institution on Friday evening last by Messrs. Shippey Bros. working from current supplied from the district mains for driving sewing-machines, small machinery, and electric ventilators. One of the Meston ventilating-fan sets working in the library was much appreciated by the ladies who availed themselves of its refreshing breezes. Although the particular set exhibited was wound for 100 volts, with 120 periods, by the insertion of a suitable incandescent lamp in the circuit, the working was remarkably steady and nearly noiseless at 43 periodicities. The motor, as showed by experiments, was easily stopped and started, and by the aid and combination of a special switch for alternating-current motor work, the motor was easily reversed so as to propel or exhaust, used either way for ventilating purposes. Messrs. Shippey Bros. also exhibited specimens of the new ⅛ h.p., ¼ h.p., and ½ h.p. "Cyclone" type of alternating-current motors, kindly lent by Messrs. Mackey, Mackey, and Co., for the occasion, for whom they act as City agents. Mr. Arthur Shippey, who was present, carried out some very interesting experiments with Messrs. Mackey's motors. By gradually pressing the negative brush on to the commutator (and leaving the positive untouched) he increased its speed by this means from 1,000 revolutions to upwards of 3,000 per minute, at which speed the ventilator produced a perfect hurricane of air; but as the brushes were again released the motor gradually slowed down again to its normal working pressure. Mr. Shippey stated that he was experimenting with several new types of semi-metallic compound brushes, as he was of opinion that to obtain perfect control, and in order to cope with the difficulty encountered by the various changes in the periodicity and load of some systems, that the problem to be solved in order to obtain perfect regulation and prevention of sparking at the commutator (when brushes were used), lies partly in the construction and type of brush; and from many experiments made on these lines, he thought that the brushes for alternating-current work should be of varied capacity and conductivity, calculated so as to meet the general working requirements of the particular alternating system adopted.

High-Speed Railways.—Electric railways have not progressed as rapidly as might be in Great Britain, but there is no saying that when once they start fairly they will not come in with a rush, as electric lighting has done. In this country the preference has hitherto seemed to be for actual railways using electric traction than for the tram lines, and as the speeds are increasing rapidly in the use of electric railways, it may be mostly on heavy high-speed lines that we shall utilise the motor. It has been urged that the electric motor will never supplant the steam locomotive, as for electric traction three sets of machinery of maximum size are required. This is one valid reason, but it is not final. There are many reasons on the other side. The coal, for instance, for a locomotive has all to be hauled to the stations, while with a central distributing scheme on a large scale, such as that of Mr. Thwaites, power only would be distributed, at much saving of cost. If high-speed railways do come—as come they must eventually—the science of line construction will require some overhauling. Mr. Charles Churchill, we notice, suggestively discussed this matter recently before the Engineers' Club of Philadelphia. For trains running on the level at 100 miles an hour a rise of 20ft. per mile (which would correspond to a drop to 80 miles an hour) should not be exceeded for ordinary lines, with a possible outside ruling to 30ft. per mile. High-speed lines, therefore, will be confined to level districts. As to curvature, this should not usually be sharper than 1deg., and no curves should exceed 2deg. A four-track line should be used, the inside two sets for passengers. The building and ditching will require extra care. There must be no open culverts, no level crossings, and solid stone bridges are advisable. Tracks should be 13ft. from centre to centre, and 3,000 ties (of white oak, 7in. by 7in. by 8½ft. long) should be used to the mile. Very strong yet elastic rails would be required, 100lb. to the yard, rigid and with wide base. A rail 5¾in. high with 5¾in. base and a head 2¾in. wide fulfils the requirements. To make the number of joints small the rails should be rolled in 60ft. lengths, and the joints, to secure smooth riding track, should be mitred—*i.e.*, cut at 45deg. (This joint, known as the Sayre joint, is used with great success on the Lehigh Valley Railroad.) The fish-plate splice is not good enough for high-speed lines. It is defective in principle, and will disappear even at the present speeds. The rail should be supported at the joint from beneath as well as at the head. Such a splice, with mitred joint (as used with 85lb. rails on the Norfolk and Western Railroad), would be the only safe one for speeds of 80 to 100 miles an hour. Spikes for fastening the rails down should give way to the Bush interlocking bolt or other rigid fastening. On curves of 1deg. or 2deg. the difference of inner and outer rail should be as much as 5in. Guard-rails should be used on inside tracks over all bridges. Switches should be few and guarded by long-distance signals; with frogs of best pattern—spring-rail frog with a ¾in. base-plate and a lever to hold it in position. An interlocking system of signals must be used, preferably electric; the speed limit may, indeed, be found to depend on the facility of signalling. On such a track the speed of 100 miles on the level, and 70 to 80 miles an hour over all, might be obtained with safety.

Mental Calculation.—In the course of some researches at the library of the Civil Engineers we have had occasion to turn up the very remarkable lecture given before the institution by George Bidder, a well-known engineer and "calculating prodigy," on "Mental Calculation," in February, 1856 (*Proceedings* Civil Engineers, vol. xv.). Robert Stephenson was in the chair, and the room was so crowded that many could not get in at all. This indicates the interest taken at that date by engineers in the subject. It is now nearly 40 years ago, and a new generation has sprung up, who, in all probability, would be equally interested in Bidder's feats of calculation. Although Bidder explained with great clearness how he had trained himself to calculate, specially disclaimed any gift beyond that of his fellow-men, and even indicated how children might be taught to equal him, not the slightest result has accrued from his explanation, and the world still calculates in the same slow and cumbrous way as before. Bidder was a blacksmith's boy, and learnt to calculate before he could read or write or knew any figures. It is always thus with the so-called prodigies, such as Inaudi, now at the Palace Theatre — though most of them were shepherd boys. Bidder counted not with sheep, but marbles, and the fact that his powers developed without knowledge of the figures at once indicates to some extent the nature of the mental conception he formed to correspond to the sounds of the names. Bidder explained that when having, for instance, 787 he saw the whole number as a reality, just as when one says "hippopotamus," one sees a huge animal and not letters. He indicates his progress: first counting 10 and then 100: no further was he taught, the rest developed from the inherent property of numbers. He knew not even the word "multiply": though he knew well, for instance, what 73 *times* 27 meant, and the answer, 1,971. He indicates how he counts this: he begins from left to right, taking the decompositions 70 times 20, 70 times 7, 3 times 20, and 7 times 3: adding them successively together and forgetting the foregoing result, thus: 1,400 plus 490 = 1,890, plus 60 = 1,950, plus 21 = 1,971. By practice he soon learnt to calculate any three figures by three figures, which was as much as could be done by a single effort, keeping the number in the mind as a solid entity. An added effort is required for numbers like 1,741 by 2,684, but practice gave this—always, mind—without knowing the written symbols; and eventually he was able, though certainly with great effort, to calculate the result of a number of 12 figures by 12 figures. He goes into the question of calculation of compound interest, and gives examples; and further relates how he astonished the Parliamentary Committee by calculating, off-hand, the time required to drain through a certain bridge of 1,000ft. waterway, 200 acres flooded to 3½ft. deep at the head allowed; result, not three weeks as expected by them, but 3½ hours. All that the lawyers could do was smilingly to ask him how many fishes would go through! At the end of his interesting lecture Mr. Bidder, while declaring he owed his whole position as engineer and vice-president of the institution, as well as his friends, to his early-acquired power of mental calculation, showed how this power might, in his opinion, be given to the children of the coming generation, if they were taught as he taught himself. There is no denying the advantage to an engineer of a power such as Bidder possessed. Yet nothing whatever has yet been done by psychologists, or mathematicians, or engineers to elucidate this interesting problem. Bidder's memoirs remain as if unwritten; and the world rests still in the absurd belief that Bidder and the other calculators possessed, not a method, but some heaven-born gift denied to the rest of mankind. Bidder disclaimed this: he explained, not perhaps as clearly as might conceivably have been done, yet clearly enough, what his process was. Instead of taking his statements and verifying them, they have been left, the world tacitly concurring in Robert Stephenson's dictum, that "nevertheless, there would be few Bidders." We incline to believe Bidder and not Stephenson; and it is perhaps well to bring again the attention of engineers and teachers to the subject, as from what we understand, there would seem to be the possibility of other investigators following up the clue shown by Bidder, and developing this power of mental calculation into a tool for the use of every member of the human race.

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 551.)

Second Design.—The transformer just designed had a comparatively long iron circuit of small section, with the copper wound round it. Hence the l for the iron was large, and the mean perimeter for the copper circuit small.

The next design shall be of the type associated with Mr. W. M. Mordey, in which the path of the magnetic lines is short, but the copper circuit has a comparatively large perimeter. We will assume, as before, a definite size of core, Fig. 12, and then afterwards alter the shape if necessary. The relative proportions of the core plates and yokes are determined by mechanical reasons. The stampings consist of hollow rectangles of such dimensions that the pieces removed from the centre will bridge the two long sides, and thus form the centre core, Figs. 12 and 13. It will be seen that with this arrangement of building up the iron circuit there will be space wasted between adjacent plates, except just at the end of the core, and only half the quantity of iron will be got in that would be if the plates were arranged to break joint as in Fig. 9. Hence the Mordey transformer, although made in the smaller sizes of the general proportions shown, is now packed up with more iron till the quantity got in is practically the same as assumed below.

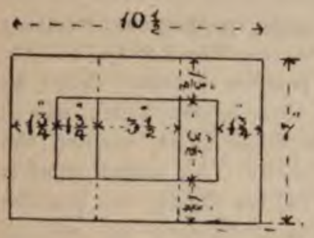


FIG. 12.

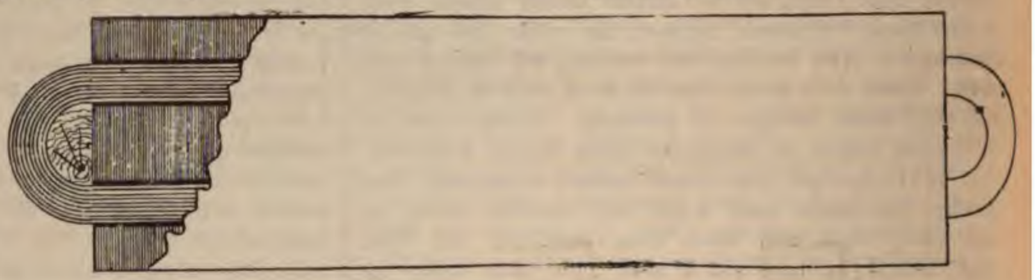


FIG. 13.

Making the transformer 3ft. long, and allowing for 85 per cent. of the space being taken up by the plates, we get for the volume of iron

$$\{(7 \times 10\tfrac{1}{2}) - (3\tfrac{1}{2})^2\}\ 36 \times {\cdot}85 = 1{,}880 \text{ cubic inches,}$$

which will weigh 526lb.

The loss we assumed in the iron is 150 watts, which gives $\frac{150}{526} = {\cdot}285$ watt per pound. From the curve, Fig. 4, this corresponds to a flux of 1,700 lines per square centimetre. Now the area of the centre core of this transformer is 3½in. × 36in. × ·85 = 107 square inches = 690 square centimetres, so that the total flux will be

$$1{,}700 \times 690 = 1{,}172{,}000 \text{ C.G.S. lines.}$$

We can now proceed to design the secondary winding. Using formula (1)

$$e_2 = 4{\cdot}45\ \mathrm{F}\ \tau_2\ n\ 10^{-8},$$

we get

$$102 = 4{\cdot}45 \times 1{,}172{,}000 \times \tau_2 \times 100 \times 10^{-8}.$$

$$\therefore \quad \tau_2 = \frac{102}{4{\cdot}45 \times 1{\cdot}172}$$

$$= 19{\cdot}6.$$

We must have an exact number of turns, as with this make of transformer the wire can only be got at at the ends of the core, and may assume 20 turns as the nearest number to the above. In this design there is as much likelihood of getting magnetic leakage as in the last, but for the present it will be sufficient to calculate the winding for two coils only, wound side by side—*i.e.*, one primary and one secondary; and then finally we must leave sufficient clearance to allow for further sub-division if necessary.

The mean perimeter of both windings will therefore be the same, and will be about 7·5ft. The number of turns of the primary is obtained from the ratio of voltage $\frac{\tau_1}{\tau_2} = \frac{e_1}{e_2}$.

$$\therefore \tau_1 = \frac{2{,}000 \times 20}{102} = 392.$$

The primary wire required to give the 1 per cent. drop at full load we get as before from (2)

$$d = \sqrt{\frac{i_1\ \tau_1\ \pi\ 11{\cdot}75}{\theta}}\ 10^{-3},$$

and here

$$i_1 = 3 \qquad \pi = 7{\cdot}5$$
$$\tau_1 = 392 \qquad \theta = 20.$$

$$\therefore d = \sqrt{\frac{3 \times 392 \times 7{\cdot}5 \times 11{\cdot}75}{20}}\ 10^{-3}$$

$$= {\cdot}0721.$$

Say 72-mil wire, covered with insulation to a diameter of 87.

In this case the space for winding is absolutely fixed by the economic proportions of the iron circuit. So it is necessary that the wire shall be such that it can be wound easily in the spaces left.

Assuming a minimum insulation of ⅛in. everywhere between copper and iron, the depth of winding may be 1·5in. and $\frac{1{\cdot}5}{{\cdot}087} = 17{\cdot}3$, so that we may use 17 layers of the above wire.

To get the 392 turns we then require 23 turns per layer, so the length of the coil when wound will be

$$23 \times {\cdot}087 = 2\text{in.}$$

The secondary will be best wound as tape in 10 layers of two turns each. The depth of the insulated tape must thus be one-tenth of the total depth available. $\frac{1{\cdot}5\text{in.}}{10} =$ ·150in., and allowing 40 mils for insulation, the thickness of the tape will be ·110in. The necessary section is obtained by (3) from

$$\mathrm{S} = \frac{i_2\ \tau_2\ \pi \times 9{\cdot}2}{\theta}\ 10^{-6},$$

and here

$$i_2 = 60 \qquad \pi = 7{\cdot}5$$
$$\tau_2 = 20 \qquad \theta = 1.$$

$$\therefore \quad \mathrm{S} = \frac{60 \times 20 \times 7{\cdot}5 \times 9{\cdot}2}{1}\ 10^{-6}$$

$$= {\cdot}083 \text{ square inch.}$$

Therefore the tape must be $\frac{{\cdot}083}{{\cdot}110} = {\cdot}75$in. broad, and will be of the following size: Bare, ·750in. × 110in.; insulated, ·790in. × ·150in. The length required for two turns will be ·790in. × 2 = 1·580in., say, 1·6in. Now the primary winding took 2in., so that for wire alone the length of window required would be 2in. × 1·6in. = 3·6in., whereas 3·5in. is the total length available for insulation and wire—see drawing, Fig. 12.

Hence with the core as sketched there is not room for windings giving a 1 per cent. copper loss in both primary and secondary.

There are two courses open if the iron parts are not to be altered. The one is to increase the copper loss by using thinner wire, which can be wound in the space, and the other is to decrease the number of turns in each winding. This will increase the induction, and hence the iron loss. We can then, however, leave the total copper loss at 2 per cent. On the whole, perhaps, the latter course is preferable, as the regulation of the transformer is impaired by allowing more copper loss. The small number of turns gives a correspondingly shorter length of copper in each circuit, and hence conductors of smaller sectional area can be used, which again decreases the space required. If we

18 turns we shall be likely to get the copper in available—3·5in. × 1·75in. The number of turns imary, τ_1, will therefore be

$$\tau_1 = \frac{2{,}000 \times 18}{102} = 354.$$

le windings must be redesigned to these figures. the primary first and replacing the old number by the figure 354, we get

$$d = \sqrt{\frac{3 \times 354 \times 7{\cdot}5 \times 11{\cdot}75}{2}}\,10^{-3}$$
$$= {\cdot}0684.$$

mils diameter may therefore be used, which will ameter when insulated of about 83 mils. The f layers will be $\frac{1{\cdot}5\text{in.}}{{\cdot}083\text{in.}}$ = 18, and 20 turns per ıld give us 360 turns. So the last layer must be ith only 14 turns in order that the total number 54.

ngth of the winding space required for the primary 0 × ·083 = 1·66in., say, 1·75in., should be allowed. ht of primary wire will be got as before from

$$g = d^2 \pi \tau_1\, 3{\cdot}02.$$
$$= {\cdot}068^2 \times 7{\cdot}5 \times 354 \times 3{\cdot}02.$$
$$= 37\text{lb.}$$

formula for the resistance we get that $r = 6{\cdot}73$ ıich, with three amperes, gives slightly over the rop allowed.

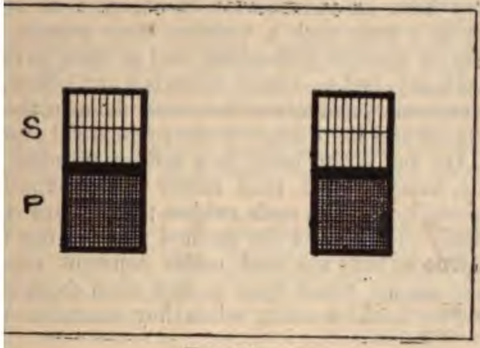


Fig. 14.

n the secondary, there are only 18 turns, which ound in nine layers of two turns each. The section inches of the conductor from

$$S = \frac{i_2 \tau_2 \pi\, 9{\cdot}2}{\theta}\, 10^{-6};$$

equal to $\frac{60 \times 18 \times 7{\cdot}5 \times 9{\cdot}2}{1}\, 10^{-6}$;

$$= {\cdot}0745 \text{ square inch.}$$

limensions of the tape must be determined as suit the space available. The insulated tape will ickness of $\frac{1{\cdot}5}{9} = {\cdot}167$in. The tape uninsulated may 125in. thick, and then a breadth of ·6in. gives the section. So tape (·600in. × ·125in.) will be used to (·640in. × ·165in.); the two turns side by side a space of 1·28in., say 1·3in. So in this design we tal length in the window of 1·3in. + 1·66in. = say wires, leaving ½in. for insulation. This will be id hence this last number of turns can be finally The weight of the secondary will be from (3)—

$$g = S \tau_2 \pi \times 3{\cdot}85;$$
$$= {\cdot}0745 \times 18 \times 7{\cdot}5 \times 3{\cdot}85;$$
$$= 38{\cdot}7\text{lb.}$$

esistance worked out from

$$r = \frac{\tau_2 \pi \times 9{\cdot}2}{S}\, 10^{-6};$$
$$= \frac{18 \times 7{\cdot}5 \times 9{\cdot}2}{{\cdot}0745} \times 10^{-6};$$
$$= {\cdot}0167 \text{ ohm.}$$

The arrangement of the winding as designed above is shown in Fig. 14, but we may find after further consideration that it is not the best method of winding when the question of magnetic leakage is considered.

The next step is the accurate determination of the iron loss and the no-load current. The induction assumed at first will be altered, owing to the change in the number of turns. From (1) we get that

$$e_1 = 4{\cdot}45\, F\, \tau_1\, n\, 10^{-8},$$

and now $e_1 = 2{,}000$, and $\tau_1 = 354$.

$$\therefore 2{,}000 = 4{\cdot}45 \times F \times 354 \times 100 \times 10^{-8};$$
$$F = \frac{2{,}000}{4{\cdot}45 \times 354} \times 10^{-6}.$$
$$= 1{,}270{,}000.$$

The area of the core being 690 square centimetres, $\mathfrak{B}$ = 1,840, instead of 1,700 as first assumed. At this induction the loss per pound of iron is ·32 watt.

The total weight of iron being 526lb., we get a loss of 526 × ·32 = 168 watts, or 2·81 per cent. For this loss, at 2,000 volts, a current of ·084 ampere will be required, which we call i_H, Fig. 3.

The data for determining the current required to magnetise the iron is got from formula (2)—

$$i_\mu = \frac{\mathfrak{B}\, l}{\mu\, \tau_1\, 1{\cdot}76}.$$

Here $\mathfrak{B}$ = 1,840; l, the mean length of magnetic path, is 17in. = 43·2 centimetres. The μ corresponding to the above induction for this iron is (from Fig. 5) 1,280, and τ_1 = 354.

$$\therefore i_\mu = \frac{1{,}840 \times 43{\cdot}2}{1{,}280 \times 354 \times 1{\cdot}76}$$
$$= 0{\cdot}0995.$$

The no-load current = $\sqrt{i_H{}^2 + i_\mu{}^2}$;

$$= \sqrt{({\cdot}084)^2 + {\cdot}0995^2};$$
$$= {\cdot}130 \text{ ampere};$$
$$= 4{\cdot}34 \text{ per cent. of the full-load primary current.}$$

The various details of the design are therefore as follows:

Six-Kilowatt Transformer—Second Design.—Ratio of transformation, 2,000/102 volts; $\sim$ = 100.

Core, 3½in. × 36in.; area of cross-section of iron, 690 square centimetres.

$\mathfrak{B}$ = 1,840; F = 1,270,000; l = 43·2cm.

Primary: τ_1 = 354; π = 7·5ft.

Conductor, 68-mil wire insulated to 83 mils, and wound in 18 layers of 20 turns.

r = 6·73 ohms, hot; loss = 1 per cent.; weight, 37lb.

Secondary: τ_2 = 18; π = 7·5.

Conductor, tape (·600in. × ·125in.), insulated to (·640 × ·165) wound in nine layers of two turns each.

r = ·0167 ohm; loss, 1 per cent.; weight, 38·7lb.

Losses—Iron...............	168 watts,	or 2·81 per cent.
Copper, primary	60 „	or 1·0 „
Copper, secondary ...	60 „	or 1·0 „
Total	288 watts	4·81 per cent.

Therefore the efficiency at full load is

$$\frac{6{,}000}{6{,}288} = 95{\cdot}4 \text{ per cent.}$$

The watts wasted at no load are 168, and the apparent watts at no load are 2,000 × ·130 = 260.

Therefore the power factor will be $\frac{168}{260} = {\cdot}646$.

The weight of iron =	526 lb., at 4d. per lb. =	175·5s.
„ copper =	75·7lb., at 10d. per lb. =	63·1s.
Total	601·7lb.	238·6s.

= 100lb. and 39·8s. per kilowatt.

The ratio of the weight of copper to weight of iron = ·144.

(To be continued.)

TRAINING OF ELECTRICAL ENGINEERS.—V.

Continuing this subject, and without dealing any further for the present with the exact requirements for a college training, we are glad to be able to give such a very practical response as the following to our enquiry, addressed to the heads of electrical firms, as to what it was exactly that they wished the young men they employ to be able to do.

Mr. Henry F. Joel, writing from the City Electric Light Works, 31, Wilson-street, Finsbury, E.C., says:

"In reply to your invitation, I am very pleased to assist you as far as I am able in pointing out the necessities for training young men in electrical engineering, and I cannot do better than give you my own practical experience with apprentices. For some years my firm have had, and have now, many applications to take lads to train as electrical engineers for the first year or two. To test the matter, we took them without premiums, with the result that we decided to take apprentices, not pupils, and to teach them the actual handicraft of the trade, but not the theory or mathematics.

"*Type of Lads.*—As to the right type of lads, we prefer to take lads who have just left school, of about 17 years of age, with an elementary knowledge of electricity and physical science (such as is given at South Kensington, the Birkbeck, or similar schools), and drawing, especially machine construction, with a good sound commercial education. We like the lads best who come to us already interested in the subject, and earnest to get on, as shown by the making of experimental dynamos, bells, or other apparatus. It is an advantage to the lad if he has to rely upon himself hereafter to earn his own living.

"*Training.*—We bind the lads for two years (this is quite time enough to give them a sound elementary training in the practical work, and not too long if the lad finds the business unsuitable). The first year the apprentice works in the shops at the bench and lathe making small parts of arc lamps, dynamos, switches, meters, electric bells, etc., and also at times, as a relief, they go as lads to assist the outdoor men, wiring houses, etc., fitting dynamos, lamps, engines, batteries, and so forth. They have to keep the same hours as the men, and work by the hour, with a record of all time on their work, so as to check the cost, and have to take their share of the work, dirty or clean, whatever comes, without favour in any way. During the second year we find them becoming useful, and then pay them by the hour, exactly what they earn, and as they improve we increase their wages. Towards the end of the second year we put them in charge of small installations, wiring jobs, etc., and we make it a point that they must be able to plan out the work, order the materials from the factory stores, and, if in the country, take on and pay local workmen or carpenters. Of course, they are not competent to undertake any but the simplest work; but after the end of two years we get them to stay with us, by preference, for at least another year. It is during this third year, when they are on their merits, that they rapidly acquire knowledge of fitting complete installations, dynamos, switchboards, batteries, etc., and are able to face any ordinary difficulty, and plan and carry out any ordinary installation. We consider them fair workmen, useful in the shop, and competent in outside work. During the first two years we insist upon the apprentices attending lectures on experimental physics and electrical engineering at one of the colleges. Our training gives them a good knowledge of tools and materials, and of the practical work generally. The constant association with electrical apparatus in the factory enables them to apply the theory and science they learn at the colleges, so that the two go hand-in-hand with the best results.

"*Comparison of Practical Training and College Training.*—We found the lads for the first six to twelve months had (somewhat to our surprise at first) but an uncertain knowledge of the simplest of the problems of electric circuits. But it is after the first 12 months that this practical system begins to tell. The lads have had to assist in a great number of jobs, all of the same class, but varied in place and character, and it is the repetition, time after time, that is necessary to fix the elementary ground work in their minds. My opinion, after some years of practical experience, is that the only practical and efficient training of lads in electrical engineering of any value is the persistent doing in different ways, on different occasions, of the same practical work—of making, fitting, and installing. It is the repetition which is the instructing necessity, and unless a lad goes through the mill of elementary work of production and reproduction until he finds himself master of the subject, he cannot and never will understand the higher class of work, and his college training and theory would be of no use to him in practical work. That is why the practical training is so much better than the best-appointed college training. The college cannot give this variety of the same work, which to my mind is so essential.

"My firm have tried a number of so-called experienced college-trained lads, and found they did not get on. Speaking generally, they had no application and no real knowledge of actual practical work. They could make beautiful joints at the bench, but were quite at a loss in the rough building, and of no use; in fact, a nuisance, as they required to be looked after to see they did not spoil work. The proper function of the college is to teach the theory, and so far as possible with practical experiment and example, but not to attempt to turn out practical electrical engineers. This, I submit, is where the colleges err; of course for experimental and laboratory work the college training is sufficient, but for practical installation of electric light, or any other electrical apparatus or industry, nothing but the training with a firm of manufacturing and contracting electrical engineers will do. In the practical training the lads have a variety of work, they have to think for themselves, and they have an inducement in prospect of better pay to push on; with such a training they acquire tact and readiness in meeting difficulties, and as they have to make their work pay, and economise materials and labour, and also to meet customers and mix with commercial men, they acquire a confidence and knowledge of the commercial aspect of the work. On the other hand, in a college training, the lads, as a rule, have one set (and rather stale) experiment, or piece of work, to do in each subject; they have the apparatus ready to hand and the method planned out for them, and only do as they are told under constant supervision: thus they are not called upon to rely upon themselves, and of course are found wanting when they commence the battle of life.

"What we practical men want the professors to teach is: Experimental physics; elementary electricity, magnetism, etc.; a thorough knowledge and repetition, with examples, of Ohm's law, and a practical knowledge of measurement of resistance and insulation; a thoroughly sound conception of practical electrical units; sample calculation of main circuits, etc.; principles of construction of dynamos, lamps, meters, etc.; lectures on steam, applied mechanics and practical machine drawing.

"In a three years' course of practical training the lads can, duringthe winter evenings, acquire a sound knowledge of these subjects, and this, combined with the practical training, will make them bright, intelligent, electrical engineers, competent workmen, and able to earn their own living, if required, at their trade; and with our system they are able to take charge and carry through any ordinary installation. In course of time, as they get more practical experience, they become thorough masters of practical electrical industry. This is our experience, and we have many of our old apprentices carrying out and in charge of very large installations—2,500 lights, 1,200 lights, etc., with steam and gas engines, dynamos, lamps, fittings, batteries, motors, telephones or bells: anything and everything electrical, and apt and ready for anything. As an example: On a recent occasion one of our old apprentices had to pass three cables through a 3in. old iron water-pipe some 250 yards long fixed underground, partly filled with water and not to be got at, and without a leading wire through; that is a problem that very few of the most experienced engineers could face: but he did it, and thereby saved our customers possibly £1,000 to £2,000 which they otherwise would have had to lay out. This speaks volumes for itself.

"In the course of our experience with many apprentices we are pleased to say that we have only had one who did not do well, and he found the trade unsuitable. This exception, we think, proves our system to be a thoroughly good one."

THE INCORPORATED GAS INSTITUTE AT BELFAST.

DENNY LANE, ESQ., M.A., PRESIDENT.

The inaugural address of the president consisted chiefly of a long tirade against electricity. We can only find room for a small portion, as follows:

. . . Within the now waning century three great developments have taken place—all from their magnitude necessarily co-operative: Gas, railroads, electricity. I am not old enough to have stood by the cradle of the first; but I have travelled on the first passenger railways in England, France, and Belgium, when I believe no others were open in the world. I saw the telegraph at work when it was open only from Paddington to Slough. I saw the earliest incandescent lamps, and heard some of the earliest telephones. "Once upon a time there was a king, and he had three sons," so begins scores of fairy tales; and gas, the iron-way, and electricity are the three "princes of the blood" whom the nineteenth century has engendered. I need not tell you that the eldest was and is, according to the story-tellers, the worst of characters; the second middling; and the youngest a paragon of all the virtues. Passing over the second prince, whose mediocrity condemns him to oblivion, let us study a little the characters of the vicious heir Gas, and the virtuous *frère cadet* of this royal house, entitled Electric Light. If the views I present seem too elementary to some of you, I have only to say I do not seek to teach those who know everything already, but rather to give a general view of the subject to such of you as have not had time to see both sides of the shield.

It may be thought that I cherish some prejudice against electric lighting. On the contrary, I have a most friendly feeling towards that mode of illumination; for, since its advent, the manufacture in which we are most interested has progressed more rapidly than at any former period. The company with which I am connected have more than once proposed to the local authority to take powers to supply the electric light; but the Corporation has dissented. When properly managed, I believe the light is beautiful, and convenient for those who can afford to pay for it; but no better evidence of its costliness can be found than that the West-end clubs of London--the richest and most luxurious institutions in the world—signed not long since a "round robin," complaining of its high price. So far as we are concerned, the new light, instead of being a star of ill-omen, has been the harbinger of success.

The figures I employ have been taken from those given by the electricians themselves. I wish that they would reciprocate this fairness, and, adopting our statements, imitate the "sweet reasonableness" which we proffer to them, and avoid the utterly unfounded statements about gas and its evil behaviour, especially its deleterious effects upon health. I may give one case from my own experience. About 50 years ago a professional friend of mine had gas introduced into every room of his house. Ten children were born there—the population running sometimes up to 16 persons. But no death took place except one—that of a lady no longer young; and it was never alleged that she was poisoned by gas. The disciples of Malthus should therefore wreck all the gasworks they could reach, if this were generally the case.

The misstatements of some of the advocates of the new light are ludicrous. Several of them assume that we manufacture nothing but gas, and "remember to forget" that the raw material yields—in coke, tar, and ammonia—products which often pay 75 and sometimes 100 per cent. of the prime cost of the coal. Again, they measure the light given by defective burners, but they allow no credit for good ones. If gas be burned in a Bunsen burner, I can show that London gas does not reach a one-candle standard, and most bad burners are modified Bunsens, in which air is unduly mixed with gas. Again, they assume that an incandescent lamp retains its original power, while it has been proved that a 16-candle lamp declines to eight candles, and averages only 12 candles. The Board of Trade was over-liberal to the new agent when it allowed 10 units to be the equivalent of 1,000 cubic feet of gas. Practical men say 12 or 13 units would be more correct, and yet these one-sided advocates put down only six units as the equivalent.

In a recent paper on the "Economy of Electric Lighting," that eminent electrician Mr. Gisbert Kapp has pointed out that, when incandescent lamps are used at the power marked by the makers, it takes 4⅓ watts to give one candle. Indeed, the electricians themselves calculate that the eight-candle lamp requires 35 watts when new, or 4⅜ watts per nominal candle—a quantity largely increased as the lamps grow older. Now London gas gives per 1,000 cubic feet 3,300 candles, which, multiplied by 4⅓ watts, gives 14,300 watts, or over 14 units, without counting cost of lamp renewals, or the serious falling off in light-giving power. Allowing a small sum for the latter item, we may say 15 units are the equivalent of 1,000 cubic feet of gas; and at 8d. 15 units cost 10s., as against 2s. 9d. or 3s. When cannel gas is supplied, the contrast would be still more striking—over 20 units to 1,000 cubic feet. Mr. Kapp proposes to overwork the incandescent lamps, giving them a shorter life; believing that the extra cost of renewals will be more than compensated by the saving in current. These wilfully blind advocates shut their eyes to the fact that a gas-burner may be checked in consumption while the new lamp must be left full on or quite off—"Hobson's choice; this or none." From counting 16-candle they have come down to eight-candle lamps; and in other small ways they have endeavoured to "whittle down" the comparative cost of the current. These statements often come from men whose names were never heard of in connection with electricity; and the authors of them might be pardoned on the theological ground of "invincible ignorance."

But, amongst them all, the boldest in reckless assertion is one who cannot plead such an excuse—Mr. Preece, the electrician to the Post Office—a public official receiving a public salary as head of the Telegraphic Department. He has become the adviser of corporations and private companies, and the competitor of independent engineers who are not paid from the public purse. I will give you one example of his dignified style, taken from his inaugural address delivered to the Institution of Electrical Engineers last January. He says: "If a full load could be maintained during the whole 24 hours, electrical energy could be manufactured for one-third of a penny per supply unit, which is equivalent to gas at 2d. per 1,000 cubic feet. The potentiality of economy in electric lighting is thus beyond the dreams of the gasman. The most marked features in the development of this great industry are the ostrich-like blindness of the gas manager, who buries his foresight in his fat dividend, and the childish wailings of the gas technical journalists. The gas industry should itself have nursed the herculean infant who is rapidly strangling its main sources of profit." As ⅓d. per unit is under ¼d. per horse-power, I can promise Mr. Preece to maintain his full load during the 24 hours when he is prepared to supply power at that rate.

"Save me from the evil spirit," exclaimed Paul Louis Courier, "and from metaphors"! Here in a small segment of a short paragraph you appear, gentlemen, as "dreamers," as "ostriches," as "puling babies," and as the "snakes" that the infant Herakles strangled in his cradle. But not only are these threadbare metaphors mixed one with t'other, but they are combined with the most ungracious language. You can determine how far it is consistent with the dignity of a gentleman, the culture of a scholar, or the *esprit de corps* of an engineer, to employ towards those whom he should regard as members of a kindred profession, terms which, if meant for wit, are devoid of humour, and if intended as contemptuous, recoil on him who fell low enough to use them. The dignified periods of Samuel Johnson are combined with vulgarity; and if hereafter his dignified and potent shade will meet that of the Mercury of the English Post Office in Elysium, it will no longer be Elysium for the latter.

Mr. Preece proceeds to say that the "electric light is essentially the poor man's lamp," although I have already told you that in the district most densely packed with palatial hotels and luxurious clubs, which use the light for the longest hours, this poor man's lamp has been found too expensive for the very capital of clubland. I will, with your permission, give some specimens of the "potentiality of wealth beyond the dreams of avarice," which Mr. Preece promises to those who embark with him on his voyage to El Dorado.

I will merely mention, in passing, the London Electric Supply Corporation; but it would be unjust to reasonable electricians to compare their schemes with that of Mr. Ferranti. By Mr. Field's tables the income of the three London gas companies is £4,724,000; while the capital is only £15,144,000, or three and a half times their annual revenue. The gas capital employed by eight large cities supplied by corporations is £8,015,000, or a little over four times their income of £1,978,000. Ten large provincial companies receive annually £1,725,000; while their capital is only £5,756,000, or three and a quarter times their revenue. The London Electric Supply Corporation in 1892 had an income of £24,282, with a capital of £836,000—equal to 34 years' revenue. This income, instead of increasing, was £4,400 less than that of 1891; and the expenditure exceeded it by £3,914, leaving a loss of this amount. Of the current generated, 58 per cent. was wasted in mains and transformers—leaving only 42 per cent. at the consumers' meters. But the distribution is now to be amended under the skilful guidance of Dr. Fleming; and the directors hope that the "unaccounted-for" current will be reduced to 30 instead of 58 per cent. But even this reduced amount looks formidable enough to the eyes of a gas engineer. As a specimen of waste, I may mention that the outlay on instruments alone (exclusive of meters and transformers) was £12,000—not far from a half-year's income—which would be much the same as if the Chartered Company were to spend £1,500,000 on pressure-gauges, governors, photometers, etc. I think I may promise for Mr. Methven that he will not advise such an outlay.

I sincerely regret the evil fortune that has attended this great experiment, which seems to have been dogged by ill-luck from the commencement; but, even under the most favourable circumstances, success could not be expected for a design planned on such extravagant lines. It may have been "magnificent," like the Balaclava charge, but it was not a serious campaign. Mr. Ferranti—the general who set the squadrons in array—seems to have exercised a spell-like witchcraft over the first board of directors. Now, under the financial management of Mr. Staats Forbes, I trust the affairs of the company may improve, especially as at Deptford he is seconded by Mr. D'Alton, an able practical engineer, who has already introduced valuable improvements, and has, moreover, the crowning virtue of being an Irishman, of a lineage which, to judge by my own experience, will not be without its value in your eyes. . . .

I will give an example of a town where gas and electricity have been in competition for over 10 years—Eastbourne—which has therefore the benefit of accumulated experience—an experience so valuable that the officials of the electric company wish to keep it all to themselves, for they have refused to give a copy of their balance-sheet to a ratepayer who had contributed his quota to the public lamps which they supplied. This was a foolish attempt to conceal what could not be hidden. The total capital of the company amounts to £37,00C, of which only £400 is preference, on which, I believe, a dividend has been paid for some time, but this year the ordinary shareholders have for the first time been accorded a dividend. Charging 9d. per unit, the balance of profit and loss is £431, of which £233 is brought forward from a previous account, leaving the annual profit £198. But £169 of this arose from the sale of fittings, and £25 was received for a pupil's fee. If these two sums be deducted, we find the profit on electric lighting amounts to £4, for earning which the directors justly received £250—too small a remuneration, when we consider the anxiety of mind caused by trying to navigate a craft so unseaworthy amidst shoals and breakers. They are now calling for more capital to be invested in this mine of gold, this "potentiality of wealth beyond the dreams of avarice," as Mr. Preece calls this "great industry." Why do the directors not ask him to devote some of the abundant leisure which he has to spare from his official duties, and by his divining-rod find this hidden vein of gold into which they have not yet sunk a shaft? In this same town of Eastbourne, when the electric light was started in 1882, the consumption of gas was 99,584,000 cubic feet; in 1887, 146,068,000 cubic feet; and in 1892, 207,036,000 cubic feet—an increase of 107,452,000 cubic feet, or over 107 per cent. Thus was this "spotted snake" strangled by the "herculean infant." An old Cork rhyme runs thus:

"It is better to fall with your back in a set of furze,
Than venture to play with those ticklish things *metaphors*"—

rhyme and reason which I commend to Mr. Preece. I may remark that this engineer has recommended the Corporation of Bristol to charge 6d. per unit; being 1,800 per cent. over what he says electricity could be supplied at "if the load factor was uniform."

It is, I think, Mr. Crompton who first invented the very useful term load factor—meaning the ratio between the average and the maximum delivery of electricity. Of course, gas engineers have a load factor of a somewhat similar kind, but their system of storage enables them to put by the surplus of the day production to help the hours of darkness. With the alternating current no storage is possible; and hence if the dynamo ceases to work for even a few seconds only, all lights are extinguished. With the continuous system, accumulators afford a partial, but a very expensive and wasteful remedy. If we put 100,000ft. of gas into a holder, and got only 85,000ft. out, we should say things were going on badly. Yet this very bad result is the very best claimed for storage cells, and in some cases the loss, I believe, is 40 per cent. The lot of the gas manager is also made more easy by the fact that a large percentage of gas is used by day for heating, cooking, motive power, and manufacturing purposes, thus filling up, to some extent, the deep hollow of the electric diagram. The sudden rise and the sudden fall of the curve produce the greatest difficulty which meets any system unprovided with storage power. Indeed, some of the statements under this head are startling. Prof. Unwin states that within the 24 hours the demand varied from four times the mean to one-twentieth of the same quantity—that is to say, that the maximum was 80 times more than the minimum output. Even in gas distribution the maximum is 50 times as much as the minimum hour.

The latest authority is Prof. Ayrton, who, in his monograph prepared for the British Electrical Section of the Chicago Exhibition, states that the average hours of consumption of the electric light in private houses is only one hour in the 24, in shops and flats only 1½, and that it is only clubs and theatres that exceed this limit. Let us see the result that this leads to. He says that the whole of the electric lights fixed in Great Britain are equal to 750,000 eight-candle lamps. Allowing even 800,000 lamps, this would be equal to 400,000 16-candle lamps; and allowing even 1½ hours would mean 600,000 lamp hours, which could be supplied by 600,000 × 5 = 3,000,000ft. of gas a day, or equal to 1,100 million feet of gas in the year. This is less than the Brentford Gas Company sells. The town of Nottingham consumes more; and the combined consumption of Plymouth and Portsea is considerably more. The total sales of gas in London are 30,000 million cubic feet. The annual increase lately has been about 6 per cent., or 1,800 millions; so that the increase of gas consumption in London alone in one year would give one and a half as much light as the whole electric lamps of Great Britian. . . .

Mr. J. Ferguson Bell, of Stafford, gives the following as the respective costs of 1,000,000 heat units:

Gas at 2s. 3d. per 1,000ft.	40d.
Electricity at 4½d. per unit	1,301d.

The latter being 32 times as dear as heat produced by gas. Electric motors for very small powers will, I expect, come into use; but for anything above ½ h.p. or 1 h.p., it is not likely that people will pay a price so much higher than gas power costs. On this subject I again refer to the authority of Mr. Bell, who gives the following figures:

Cost of gas power at 2s. 3d. = 0·675d., say, ⅔d. per horse-power.
Cost of electricy at 4½d. = 4·500d. per horse-power, or, say, 6⅔ times the price of gas power.

Let us now examine what modes have been proposed to get over this difficulty; and, at the outset, it is as well to say that no plan has ever been devised to store electricity itself. The garnering up of other forces forms the only mode of meeting the difficulty of the fat kine and the lean kine—of the brief harvest, and the long winter. These forces have afterwards to be transformed into electricity.

First—to begin with the storage cell—no electricity is stored there. It is chemical energy which is laid up. If I take a piece of carbon and a piece of zinc, connected by a good conductor, and place them in an acid, well-conducting and easily decomposed liquid, the zinc will first be oxidised; and the oxide so formed combining with the acid will form a soluble salt. When the zinc has all been dissolved, I place a second carbon in the solution, and send through it a current of a strength sufficient to decompose the salt, when the metallic zinc will abandon the acid and be deposited on one of the carbons, leaving the free acid in solution. We have, therefore, what we began with—zinc, carbon, and an acid solution; and, connecting the zinc and carbon as at first, we begin the series again, and repeat it as often as we like, the zinc being alternately oxidised and deoxidised. This is precisely what occurs in the so-called storage battery. The lead compounds are alternately deoxidised and again oxidised, thus alternately absorbing and evolving a current. In both the cases referred to the oxidation of the metal produces a current, and then an independent current produces deoxidation. As far as I can recollect, Sir William Grove, to whom science owes so much, was the inventor of the first storage system, which he called a "gas battery." A current was passed through two platinum plates and decomposed water—in fact, deoxidised hydrogen—the hydrogen and oxygen being collected in separate tubes. The battery wires were then removed, and the two platinum plates connected by a wire passing through a galvanometer, when a current was observed to be produced by the reoxidation of the hydrogen and the reconversion of the gases into water. Gaston Planté discovered that by alternate oxidation and deoxidation of plain lead plates similar effects were produced. Then came the innumerable forms of the Faure-Sellon process, in which the lead plates were "pasted" with oxides of lead already formed. Yet I believe that, taking into account durability, no system has yet been invented better than the original Planté process, still surviving in the Howell-Crompton and other systems of accumulators. I have said so much in order to show clearly that in these cells there is no storage of electricity. Indeed, it would be wonderful if any prison could be designed to confine a spirit, not "airy," but far more subtle—in fact, "ethereal." As electricity has even disdained the chain of a definition, it does not seem likely that it will be "cabined, cribbed, confined" in any material cell. It passes the wit of man to devise the cunning cage that could confine such a wild bird. These storage cells are undoubtedly often of great use in supplying a small output during the hours of lowest consumption, leaving engines and dynamos at rest for many hours. They are also of use during the hours of heaviest duty, and particularly in steadying the current when the dynamos are running. They are, however, enormously expensive, and occupy a very large space; and I believe there have been explosions caused by the hydrogen evolved. Mr. Kapp, in his lecture at the Society of Arts, puts down their prime cost at £40 to £50 per kilowatt; and as 1,000 cubic feet of gas are equal to 30 kilowatts, we have thus £1,200 to £1,500 for storage, as against £12. 10s. for gas. Mr. Kapp referred to comparatively small plants; and I believe for large central stations the capital would be less. But even if it were reduced to half, the cost of electric storage would be still 50 to 60 times as dear as gas storage. In addition, the depreciation is very heavy, and with wear and tear, maintenance, and interest, would sum up to 15 or 20 per cent. Their disadvantages are fourfold: (1) heavy outlay on capital; (2) very large space occupied; (3) heavy cost of maintenance; (4) loss of current, which, in the most favourable circumstances, amounts to 15, and is often over 40 per cent. They can never be used economically, except as auxiliaries—a kind of very heavy dragoons, to guard the flanks of the main column

Two other modes of storage have been recommended by very eminent professors; and nothing can more clearly emphasise the difficulty to be encountered than the fact that systems so complex, so expensive in construction, and so wasteful, should be even thought of.

Prof. Forbes, having to deal with the case of Edinburgh—a place possessing for such a system natural advantages such as no other city in the British Island enjoys—proposes to pump water for all the 24 hours, if necessary, to a reservoir situated at a great elevation, thus storing the potential energy of the elevated water. The water so stored is to actuate during the lighting hours turbines driving dynamos to produce the current. The natural advantage which Edinburgh possesses is this: that within 1½ miles of the city it has, on Arthur's Seat, a natural reservoir at an elevation of 800ft., and the capacity of this reservoir can be extended. As it exists at present this reservoir can hold sufficient water to supply 1,000 h.p. for two hours.

For motive purposes, the efficiency of a reservoir is the product of two factors—vertical height and capacity—the number of foot-pounds got by multiplying the elevation in feet by the number of pounds of water stored. Some strange mistakes have been made on this subject, and owners of water power have imagined that they have had what they called "a fine ponding power," when it really has been of very small amount. A good many years ago I devised the following very convenient formula, which some of my friends have associated with my name. In it I have assumed that the efficiency of the water-motor is 75 per cent.—a very fair allowance when losses by friction, part-gate, etc., are taken into account. The formula is this: "One acre of water, 1ft. deep, gives 1 h.p. for one hour for (each) 1ft. of fall."

This tells us at a glance how large the impounding reservoir must be unless the elevation be very great. Prof. Forbes has therefore at Edinburgh the unusual good chance of a ready-made reservoir at a very great elevation, and very near the city. Yet, under these circumstances, let us see what the losses may be, independently of the fuel used by the engine which drives the pumps.

First, the efficiency of the pumps themselves (including leakage of valves) cannot, I suppose, be higher than 85 per cent.; friction of rising main, which, being continuously at work, may be of smaller dimensions than the falling main, may cause a loss of 10 per cent.; for delivery main, say the same; efficiency of turbine, 75 per cent. Of course, I do not take account of efficiency of dynamo, which would be the same as if it were driven directly by steam-engine. The ultimate efficiency would, therefore, be ·85 × ·90 × ·90 × ·75 = 51 per cent. We should also count for interest and depreciation, say, 15 per cent. on the pumps and turbines, and 6 per cent. on the mains, and 5 per cent. on any outlay required for the extension of the impounding reservoir, besides rent and cost of "way-leave."

Against this the economies would be the cost of smaller steam-engines (worked, however, for longer hours), and the saving of fuel lost in getting up and letting down steam. We have also to look to the additional contingencies which arise under this system. The bursting of a main, the breakdown of the pumps, the sticking of a valve, the choking of the turbines—any one of these events would stop the supply of light. Even in the very favourable position of Edinburgh, I cannot see that this system commends itself to engineers. . . . .

I come to another obstacle in the way of electric progress—viz., the cost of conductors. As long as overhead high-tension conductors were allowed, the difficulty was not so great. But since the Board of Trade nearly always requires underground conductors, the cost has been greatly enhanced, and two systems have been adopted—for the low-tension system, bare copper rods laid in concrete culverts; and for both low and high tension insulated cables, generally drawn through cast-iron pipes, which are sometimes filled with oil. Both of these modes are very expensive, and this has led to the transformer system, which is the most important development that has taken place during the last dozen years.

The transformers are of three totally different kinds, as they are to be used by the continuous or alternating current. In the first case, the transformer consists of an electric motor made to revolve by the current, the same axis carrying a dynamo, the revolution of which in a magnetic field generates a current of lower voltage. In the first step, the electricity is converted into motive power, which is again converted back to electricity. The first may be a current of high tension requiring a cheaper conductor, and the secondary current may be of the lower tension used in electric lighting. As in each of these conversions we get out, say, 86 per cent. of what we put in, the result is about ·86 × ·86, or under 75 per cent. of the originating current, without counting the loss in the primary main. For the low-tension system another plan has been used—viz., four sets of storage cells are charged in series by an originating current of, say, 400 volts, until each set can give a tension of 100 volts. They are then disconnected from the charging mains, and discharged separately through the service mains at 100 volts. The object of the whole arrangement is to diminish the cost of the conductors in the ratio of over 3 to 1; but the heavy loss incurred by storage cells, their great cost, and rapid deterioration, are inseparable from this system.

As a motor actuated by an alternating current has not yet come into practical use, another device has to be resorted to, the germ of which, as well as those of many other inventions, is to be found in Faraday's earliest papers on the subject. Taking a soft-iron ring, he wound on different parts of it two coils of insulated copper wire. On making or breaking a battery current through one of these coils, a momentary current was produced in the other. The alternate-current transformer of the present day consists essentially of the same parts—viz., a soft-iron core wound with two coils; one of thin wire, through which the original alternating current is carried, and the other of thicker wire, through which a current of lower tension is generated fit for electric lighting. A common proportion is 2,000 volts reduced to 110 volts.

Now the only object of all these transformers is to diminish the cost of the conductors from the central station; and the relative cost of conductors depends on this principle. What the electrician sells is a watt; but the watt, like the foot-pound (to 44 of which it is equivalent), is a compound unit, being the product of the volt and the ampere. To secure a given product, we may make one factor very small by making the other very large—1lb. falling 1,000ft. is the equivalent of 1,000lb. falling 1ft. Now the heating of the conductor, and the dissipation of energy as heat, in no way depends on the volts, but altogether on the amperes being proportional to the square of the amperes, multiplied by the resistance. Small wires offer more resistance than large ones, ; and to secure a sufficient number of watts through them, we must increase the volts and lessen the amperes, which alone cause the heating and loss of energy. The whole object, therefore, of these systems is to diminish the cost of the conductors; and it seems now to be generally agreed among practical men that it is not economical to send more than 1,000 amperes per square inch as the maximum current that a copper conductor can safely carry—a quantity which at 100 volts would supply about 750 16 c.p. lamps. But I find that Mr. Crompton, in his celebrated paper on the relative efficiency of alternate current and battery transformers, allows only 720 amperes per square inch. Mr. Crompton says that a double conductor, each of 1½ square inches section, shall be used for 1,080 amperes. At 110 volts it requires about seven amperes for a horse-power, so that the 3in. of copper gives only 154 h.p. It would, therefore, require two sets of these double conductors to deliver as much power as a 6in. gas-main could carry; and the cost, instead of £500 or £600, would now run up to £1,100. If the gas pressure was increased to 16in., the corresponding electric conductors would cost £22,000. If the alternate current is employed, the insulated cables would, by Mr. Crompton's calculation, cost 2·63 times as much. Besides this, there would be considerable loss of electricity, and practically none of gas, in a main laid specially for the purpose and not tapped for service-pipes.

But this change of tension cannot be effected without loss. My friend, Mr. Mordey, appears to have been very successful with the closed while Mr. Swinburne advocates the open Hedgehog transformer. What the loss is, I would be afraid to say; but it used to be laid down that these transformers had a high efficiency when on a full load, but showed great loss at low loads. Originally each house was supplied with a separate transformer. Now, I believe, the transformers are "banked," using a large number, or those of large size, for the heavy hours, and a smaller number for the light hours. I must say I am rather surprised at the high yield claimed for some of them, and I should like to see some reliable return of the number of watts put into the main at the station and the number paid for by the consumer, for this is really the financial question to be settled. Dr. Fleming, who has devoted so much time and ability to this subject, estimates the efficiency of both forms open and closed throughout the 24 hours at 75 per cent. At Deptford they only hope for 70 per cent., representing a truly formidable loss.

Is there any way of getting out of this difficulty about conductors? I allege there is; and again I say the remedy is in your hands. Instead of distributing electricity, distribute gas to be used in gas-engines near the spot where the electricity may be required. When, about a year and a half ago, I began to investigate the question seriously, I was surprised at the great economy of "distribution of energy by gas." Of course it was only potential energy, and it would have been more correct to speak of the distribution of gaseous fuel. . . .

Now let us take a glance at hydraulic transmission by a 6in. main, which, of course, for 750lb. pressure must be far more expensive than a gas-main which has to bear only ½lb. or the 1,200th part of that in the hydraulic main. This expensive 6in. main will carry only 116 h.p., instead of the 600 h.p. which the cheaper gas-main can convey; and while there is no appreciable loss on the gas-main, there is a loss of 20 per cent. on the hydraulic main. The cost per horse-power by high-pressure water may on an average be put down at 14d. for small, to 5d. for the largest powers, against ¾d. per horse-power for gas.

To revert to the question of storage, I may give Prof. Unwin's figures. The capital cost of storage of one horse-power hour is estimated by him as follows:

Gas	£0	5	6
Thermal storage with condensing engines	1	13	0
Thermal storage with non-condensing engines	2	5	0
Epstein storage cells	8	0	0
Storage cells at Frankfort	23	0	0

Storage cells Mr. Kapp gives as £30 to £37.

Next with respect to loss in storage:

Gas	0	
Storage cells—average	20	per cent.
Transformers, high-tension	25	,,
Storage battery, transformers	25	,,
Thermal storage—not ascertained, but considering loss by radiation, say	20	,,

Loss in transmission:

Gas	1	
Electricity	10 to 30	per cent.
High-pressure—hydraulic	20	,,
Low-pressure, as at Edinburgh	50	,,

It may seem strange to some minds—especially those with municipal interests—if I make the following statement: I think it is a pity that the electric light was not handed over to those who were already the purveyors of light to the public—I mean the gas manufacturers. In some cases this system has been recommended, but even where gas companies work independently of the corporations, I believe that they could supply the light on better terms than any separate organisation. The reasons why I believe this result could be obtained are: 1. There would be no necessity for a second staff of directors, secretaries, engineers, accountants, collectors, etc. 2. In most cases there would be no need to purchase or rent any additional land. 3. A considerable portion of the existing staff of the gasworks could manage engines (and even boilers, if such were required) with but little additional cost. 4. The storage can be provided at a very low cost, and so eliminate the great difficulty arising from the great fluctuation of demand between one unit and 80 units. 5. If generating stations are placed at a distance from the works, the feeding gas-mains cost very little; the power employed for transmission is infinitesimally small; and the loss by leakage practically nothing. 6. The cost of production per unit is very much lower than by any other system. I believe that in most cases gas of low illuminating but good heating power can be produced on the works for 1s. 6d. per 1,000 cubic feet, and leave a profit; no outlay having to be incurred for mains, services, and meters—mains being charged as conductors.

As an example of what may be done with even a small plant worked with three 16-h.p. nominal gas-engines, and using 70 E.P.S. cells of the K type, I quote from actual working returns. The average of the results for August and October gives the cost of

Town gas at 3s. 3d. per 1,000 cubic feet as	1·550d.	per unit.
Labour	0·425	,,
Oil and waste	0·014	,,
Water	0·033	,,
Total	2·022d.	per unit.

If, however, heating gas can be made at a profit for 1s. 6d. per 1,000ft., the first item (cost of gas) would be reduced to 0·71d.; and the whole cost would be only 1·182d., or considerably under 1¼d. per unit, a cost less than is incurred in many cases where water power is employed.

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THE GAS ADVOCATE.

If a friend is needed to defend, or an opponent to combat, give us an Irishman, for we then get a man whom Nature has endowed with the faculty of language—a born rhetorician, a speaker whose rich and vivid imagination supplies him with a plethora of sounding words that carries away the hearers and proves for the nonce that black is white or white is black. Such a man is the president of the Gas Institute, whose attack on matters electrical, in a presidential speech at Belfast on Tuesday, was well worth listening to, even if taken as the argument of an advocate who, with a difficult task before him, laid himself out to make out a good case by a display of verbal pyrotechnics such as none but an imaginative Irishman could produce. As one of the cleverest specimens of what those impregnated with gas interests can put forward in attack upon electrical matters, commend us to this presidential address of Mr. Denny Lane. Some of us view with equanimity the smiting by big words between such giant controversialists as the president of the Institution of Electrical Engineers and the president of the Gas Institute, and many will back the Englishman for lasting. We cannot hope to approach, much more to excel, these masters of verbal fence in attack or defence, but we can direct attention to some shortcomings in the attack. It becomes not a man to throw stones if he himself lives in a glass house, yet while Mr. Denny Lane makes some strong remarks on Mr. Preece's unprofessional patriotism, he by inference tells all electrical engineers that they are incompetent. He says: "When properly managed, I believe the light is beautiful, and convenient for those who can afford to pay for it, but," etc. Just previously we are told the author had "more than once proposed to the local authority to take powers to supply the electric light." If this does not mean that hitherto electrical engineers have mismanaged their affairs, and that Mr. Denny Lane could manage them better, we know not what is meant. Certainly, we believe in a man who has confidence in himself, but there is such a thing as over-confidence, which some folks are apt to term conceit. Mr. Denny Lane next argues—if our interpretation is correct, and we humbly beg his pardon if it is not—that gas is the healthy artificial light *par excellence*. He cites one instance to prove his contention, that of a house in which ten children were born, where the inmates sometimes mustered sixteen, and where in the course of fifty years only one inmate died—"a lady no longer young, and it was never alleged that she was poisoned by gas." What this proves as regards the healthiness of gas we cannot perceive. We know a man who has for forty years worked in and about sewers, and is not dead yet, but what this proves with regard to the healthiness of sewer work, we leave Mr. Lane to say. Because a man lives to a good old age, hale and hearty, whose work has all his life been connected with lead, or at a grindstone in Sheffield, it does not prove that these occupations are healthy. The so-called misstatements mentioned by Mr. Denny Lane again carry no weight. "Some of the advocates," "several of them assume," "they measure the light," and so on, are phrases that mean nothing and prove nothing. Subsequently, Mr. Lane ceases to deal in generalities, and gives an *olla podrida* of specific mixed with general. The proposition mentioned by Mr. Kapp, in his lecture at the Society of Arts, to slightly overrun incandescent lamps for economy's sake, is thus met by Mr. Lane: "These wilfully blind advocates shut their eyes to the fact that a gas-burner may be checked in consumption, while the new lamp must be left full on or quite off." This is a text we should like to preach from for the full period that used to be allotted to the parson in olden days. We contend that a bigger sanitary curse in a room cannot be there than a half-turned-off gas jet. It is a stinking nuisance; but with this we will not deal. Mr. Lane knows—none better—that turning down a gas jet does not mean a saving in gas equivalent to the loss in light. He knows also that whatever may be said about turning down, as a matter of fact neither servants nor workmen will systematically turn down, and that once the gas is lighted it flares away without diminution from the time it is lighted till the time of leaving off work or going to bed. He knows, too—none better—that one of the points insisted upon by the advocates of electricity is the ability to turn the lights on or off when entering or leaving a room. With gas, the jets in the dining-room, drawing-room, or bedroom, once lighted are lighted for the evening, admitting they may be turned down. With electric lamps the lights are switched on or off as required, and our information from users is though, lamp for gas-burner, the electric lamp is the more costly, yet owing to this switching arrangement the total bill is not greater, and in many instances is less. What, again, must be said of the honesty of the argument which says that the "8-c.p. incandescent lamp requires 35 watts when new, or $4\frac{3}{8}$ watts per nominal candle, a quantity largely increased as the lamps grow older," and immediately after arrogates to London gas 3,300 candles per 1,000 cubic feet? Depreciate your opponent, and put gas up to a theoretic value which is not obtained in any ordinary burner in any house or shop in the metropolis, and so make the apparent difference in calculated cost as wide as possible. But space will not permit us to traverse through the sentences of this long address to show how half-truths are made to do duty, as they usually are, to mislead rather than to show the true facts of the case. Is it not misleading to take the London Electric as a sample of the value of electric lighting? Because a company makes blunders and wastes a lot of money, that is no reason why a company that does not blunder and waste should not be successful. Similarly, we might say of Eastbourne, that it is not a fair sample of work to show. Let us make a supposition to this effect. Suppose Eastbourne lighted throughout by electricity, and after years of such light a gas company to start in opposition, would that gas company be in a favourable position to earn dividends, and whether it was or no, what would be the value of its position to show the capabilities of gas? So far as we know, the major portion of electrical engineers of repute are careful to understate rather than overstate when dealing with practice, and we cannot affirm even that they ride the high horse when dealing with the theoretic possibilities of generating electrical energy. Perhaps Mr. Denny Lane will carefully check Mr. Preece, and tell us the weight of coal per hour to get a brake horse-power hour with the very best type of engine; take the efficiency of the dynamo at 85 per cent., the present price of coal, and say what a horse-power costs. Mr. Preece never said he could supply at that cost, and Mr. Denny Lane is mistaken in leading his audience to have that impression.

TESLA.

We commenced in our last issue the complete text of the lecture by Mr. Nikola Tesla delivered before the Franklin Institute, and also before the National Electric Light Association in America. We shall not enter into any discussion upon the probable outcome of Tesla's experiments, opening as they do an almost entirely new field of exploration—following investigations of Crookes and others—but would point out that, although what we term statical electricity has for many years seemed to have little or no practical outcome, the discoveries of Crookes, Spottiswoode, Tesla, and others, may lead to some very practical applications in this branch of electricity. Mr. Tesla's lectures in America, as well as that delivered at the Royal Institution in England, and fully reported in our columns, consist to a very large extent of practical demonstrations fully illustrated and explained in the text. We think, however, in these American lectures Mr. Tesla has taken us more into his confidence, and given us an indication of what we may term his mind work. He gives us, in fact, the text upon which he is labouring. As will be seen by an examination of his lecture, the first portion of it is devoted to a consideration of the eye. As the lecturer points out, the eye is the only human organ directly affected by that subtle medium which scientific men tell us occupies all space, and which they term ether. If we accept the scientific jargon of the day and accept this view of the ether and its endowment with all the properties required to demonstrate the correctness of the scientific views put forward relating to light and electricity, the difficulties are greatly lessened. Some people, however, unfortunately, do not accept the modern views, but think they may be as far astray as were the views of the ancient Greeks with regard to astronomical questions. Mr. Tesla points out that in recent years—and we cordially agree with almost all he says—the scientific advances have been extremely rapid. Centuries ago men thought and invented and imagined they were soaring ahead, while we, who look back at their work, see that they were really going at a snail's pace. We can but ask as to the reality of our advance, Are we not in the same position as men centuries ago, thinking we are advancing rapidly, and will not the men who come centuries after us look back and say they imagined they were soaring rapidly, but in reality they were moving very slowly?

But whatever may be the criticism upon the text which is causing Mr. Tesla to work, there can be but one view in regard to the energy he has thrown into his investigations and the wonderful facility which he seems to possess of looking into the very nature of these mysterious phenomena. According to the existing scientific view, electromagnetic phenomena are manifestations of energy which is supposed to be of the same class as those of radiant heat and light—that is, manifestations of energy through the medium of the ether. Our present knowledge leads the author of these lectures to look far ahead, and to point out that "the day when we shall know what electricity is, will chronicle an event probably greater and more important than any other recorded in the history of the human race. The time will come when the comfort, the very existence, perhaps, of man, will depend upon that wonderful agent." The author goes on to point out that when our coalfields are exhausted and our forests have disappeared, one thing will remain, according to our present knowledge—that is, to transmit power at great distances. Men will go to where Nature provides the power; they will harness the waterfalls, and transmit the energy from the points where Nature provides it to the points where they require it. Habitations and factories at a distance of hundreds—perhaps thousands—of miles may be supplied with heat, light, and energy, according to the requirements, from the centres which Nature provides. Such, we take it, is the text which has induced Mr. Tesla to work, and which he describes in the earlier part of his lecture.

The remaining part is descriptive of apparatus and experiments—experiments of the most ingenious and convincing character, giving results which must appeal in the strongest manner to everyone engaged in industrial operations, indicating, as they do, a new sphere of industrial activity. Mr. Tesla, like all real workers, is extremely modest as regards his achievements, but we cannot allow without protest these results to be considered as insignificant—the term he gives to them; and we think our readers will agree with us, when they have read the whole of his lecture, that far from being insignificant they are of the greatest significance, and that even in the short interval which has elapsed since his lecture in England and his lecture in America, considerable progress has been made in the direction in which he has devoted his attention.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PARIS MAINS.

SIR,—We note that in your issue of the 2nd inst., by a paragraph on page 545, you call attention to the failure of the Popp Company electric light mains in Paris. As you are aware, the system used is not the same throughout, and we should be obliged if you would allow us to make a correction. This company has supplied about 40 kilometres of indiarubber-insulated cable for high and low tension distribution to the Popp Company for Paris, and although these cables have now been in use for a few years, in no single case has a failure been reported, and we understand these cables have in every way proved satisfactory.

The canalisation of the Popp Company is now being considerably extended, and we have now on hand some 18 kilometres additional of vulcanised rubber-insulated and armoured cables for these extensions to meet the present requirements, and understand that further extensions are contemplated, using the same type of cable.

As the general statement, as it now stands in your journal, may give rise to some misunderstanding, we should be obliged if you would find space for this correction.—Yours, etc., MATTHEW GRAY, Managing Director.

India Rubber, etc., Company, Silvertown, June 10.

REVIEWS.

Portative Electricity: a Treatise on the Application, Methods of Construction, and the Management of Portable Secondary Batteries. By J. T. NIBLETT. Published by Biggs and Co., Salisbury-court, E.C.

The author of this book has succeeded better with the contents than the title. As a synonym for "portable," the expression he uses must be considered obsolete, although there is perhaps no harm, but even some good, in reviving it. "Portated electricity," though more correct, would hardly be euphonic—but this is not the place for linguistic studies: we may better study the inside of the work under review.

Taken as a whole, the prevailing thought in the mind of anyone—reviewer or not—who reads this book will be one of astonishment at the extraordinary number and diversity of uses and purposes to which may be put accumulators or secondary batteries or appliances containing a store of electric energy. Even the tolerably complete list which Mr. Niblett draws up and particularises with a great number of interesting facts and illustrations, will probably require some additions by the time that his book is in the hands of an appreciative public; and the reviewer of similar works in the future will find it perhaps more easy to enumerate the purposes to which this portable plant is *not* applicable, rather than the converse. It reminds one of the learned master, as to whom it was said that what he didn't know wasn't knowledge.

The book—like Gaul of old—is "divided into three parts": the first of these, constituting rather more than half of the entire work, embraces the different uses to which is adapted the electric energy stored away in secondary batteries. The second part contains in very brief form the leading details of such accumulators as have in any real sense been proved of service for hard work; whilst Part III. embodies what will be more especially valued for its practical facts and instructions—a handbook and guide to the proper management and use of the necessary appliances. In fact, the last 50 pages of Mr. Niblett's work contain a great deal of valuable information which alone should serve to sell the book. The pictures and interesting particulars in the first part may be looked upon by some as the gilding to the pill of knowledge; but we hope that they were not included by the author in his book merely for the sake of an attractive appearance. An *edition de luxe* is not essential to the careful running of batteries, although even the practical may always with advantage be made beautiful as well.

There are many points of interest to notice and criticise all through the book. In his very introduction the author defines "voltaic couple" in rather a loose way—for a work intended more especially for non-technical readers; but fortunately an exact definition of its constituent parts is not essential to the proper working of a battery. "Portative" electricity in mining operations constitutes an important part of the earlier pages in this book. A long and elaborate report upon miners' safety lamps tested on the Continent would appear to show a greater readiness there to adopt these appliances than in this country. Considering how overwhelmingly important our coal industries have been and are, it is surely time that British mineowners paid more attention to electric safety lamps, even though their prime cost be greater than those employing oil. In cost of maintenance, the advantage appears to lie very strongly with the electric lamp, the expense of electricity for each lamp per shift not exceeding $\frac{1}{10}$ of a penny.

Electric filters, portable lamps for photographic purposes, each with a ruby glass, domestic safety lamps, lamps for Customs inspectors, gas workers and inspectors, firemen (to use where dense smoke or fumes will not allow ordinary lamps), reading lamps—in connection with which Mr. Niblett pokes a little sarcastic fun at the railway companies, by illustrating the interior of a compartment absolutely without light except for what is furnished by a portable lamp belonging to one of the passengers—surgical appliances, not only for lighting the body inside or out, but also for cautery and galvanic purposes generally : all these are dealt with at length and in a very attractive manner.

However, the list of uses to which portable electricity may be applied is far too long to enter upon here : suffice it to say that Mr. Niblett has compiled a very entertaining description—profusely illustrated—of the leading purposes wherein it might serve. The details under the heading of "Traction by means of Portative Electricity" are, however, it must be said, extremely short, and not by any means sweet, though Mr. Niblett writes more severely as to what has been done in this direction than what might be attempted.

Of the more practical portions of the book, space only allows a very brief notice. Nearly all cases of failure of secondary batteries, says the author, are caused by sending the charging current either in the wrong direction or at too high a rate, or for too long a period ; and he gives very elaborate precautions which ought to be adopted in order to guard against these failures. Tables are given also to show the times necessary for recharging various numbers of cells, from different circuits and with different resistances (usually a single lamp in series), but even for the sake of completeness it would seem hardly essential to carry the figures so far as 625 hours, which appears to be the time required to recharge 39 five ampere-hour cells in series with an 8-c.p. lamp from a circuit of 100 volts. People don't usually care to wait for at least a month whilst lamps are being recharged.

In showing his adapter for charging portable lamps from a house circuit, the author does not sufficiently emphasise the necessity for ascertaining first which is the positive wire in the latter, presumably relying upon what he says earlier in this connection, but the necessity for so doing might with advantage be repeated wherever possible.

The misprints usual to a first issue are, of course, to be found, but we only touch upon them in order to mention one which is too good to lose, although it may lead to discord rather than music between the author and his printers. The creeping of a battery solution is said by the latter to somewhat resemble a "symphoning" operation!

Mr. Niblett, however, has written a very useful book, one of value not only to the lay user of portable electric energy, but even one which may serve to interest the electrical engineer so far as to secure an abiding place on his bookshelves.

MULTIPLICATION OF THE NUMBER OF PERIODS OF SINUSOIDAL CURRENTS.

BY DÉSIRÉ KORDA.

I have shown in a previous paper (Académie des Sciences of Hungary, November 14, 1892) that by revolving field magnets excited by a sinusoidal current, there is obtained in a fixed circuit placed in the magnetic field with rotary axis so produced, a current of double the number of periods.

I wish to indicate here how this arrangement may be used to treble the number of periods of a sinusoidal current while yet, in speed of rotation, not exceeding synchronism with the inducing current. The advantages which may accrue from an important increase of the number of periods—viz., the possibility of doing away with the iron and its hysteresis in transformers, as well as rendering the employment of condensers possible, while considerably reducing the capacity necessary to combat self-induction—are sufficiently well known for there to be need to insist thereon. Each step upon this path is therefore important.

Let us imagine that the two fixed field magnets of an alternator are excited by a current of period T, and that the armature is composed of two windings in the form of two coils, a and b, closed upon themselves and perpendicular one with the other as well as to the axle. Then as soon as the axle is rotated synchronously with the current T, each of the moving coils will be the source of a current of period $\frac{T}{2}$, as I have previously stated. If at the moment when the intensity of the magnet fields, $H \sin \frac{2\pi}{T} t$, passes through zero, a is perpendicular and b parallel to the direction of the field, there will be set up in the first a cosine current and in the second a sine current. Their expression will be

$$i_1 = \frac{HS\nu}{\rho} \frac{2\pi}{T} \cos\left(\frac{4\pi}{T} t - \phi\right)$$

$$i_2 = \frac{HS\nu}{\rho} \frac{2\pi}{T} \sin\left(\frac{4\pi}{T} t - \phi\right)$$

where S is the area of a turn, ν the number of turns, ρ the apparent resistance of the winding, and ϕ the angle of lag due to self-induction.

The two magnetic fluxes which result, Φ_1 and Φ_2, combine to produce a rotary magnetic field whose constant intensity will be

$$\Phi = \sqrt{\Phi_1^2 + \Phi_2^2},$$

and the angular speed relative to the fixed position of the windings in space will be $\frac{4\pi}{T}$. But as these windings possess themselves an angular velocity of $\frac{2\pi}{T}$, it follows that, according to whether the rotation of the field is in the same direction or the contrary, that the angular speed of the magnetic field relative to the windings of a fixed coil will be either $\frac{6\pi}{T}$ or $\frac{2\pi}{T}$. This field will, therefore, induce in a coil, c, placed so that the fixed field magnets can have no inductive effect on it, in the first case, a *sinusoidal current having thrice the number of periods*, and in the second place, a current having the same number of periods as the inducing current.

The second case will be produced, conformably to Lenz's law, whenever the currents of the two moving coils differ equally by 90deg., as to the induced E.M.F.'s. On the other hand, if we produce in one of these windings, for the current, a lag of 180deg., its magnetic field will be reversed and the resultant field will turn in the same direction as the axle. The simplest way is to fix upon the same axle another pair of perpendicular coils, a' and b', placed behind a and b, and connected each in series with one of these latter. The field produced by a' and b' will turn in the same direction as the axle, provided that one of them be wound in inverse direction to the coil with which it is connected in series. The arrangement then needs no brush.

We can apply the same disposition in the case of a multipolar alternator by making a pair of perpendicular coils, a' b', correspond to each field-magnet pole. The number of poles being $2m$, and n the number of revolutions per second, the current thus transformed will have a number of periods $3mn$ per second.

In the case where the rotation of the axle is exactly synchronous, the integral of the couples acting on the armature and magnets is nil. To obtain this synchronism, the moving parts of the apparatus can be fixed direct on the axle of the generator.

If, on the contrary, the axle turns with an angular velocity $\omega' \lessgtr \omega$, where $\omega = \frac{2\pi}{T}$, we have, for the currents induced in the moving windings:

$$i_1 = \frac{A}{2\omega'}\left[\frac{\omega+\omega'}{\rho_1} \cos \overline{(\omega+\omega')\,t-\phi} - \frac{\omega-\omega'}{\rho_2} \cos \overline{(\omega-\omega')\,t-\psi}\right]$$

$$i_2 = \frac{A}{2\omega'}\left[\frac{\omega+\omega'}{\rho_1} \sin \overline{(\omega+\omega')\,t-\phi} + \frac{\omega-\omega'}{\rho_2} \sin \overline{(\omega-\omega')\,t-\psi}\right]$$

and putting

$$\tan\phi = \frac{L(\omega+\omega')}{R}, \text{ and } \tan\psi = \frac{L(\omega-\omega')}{R}$$

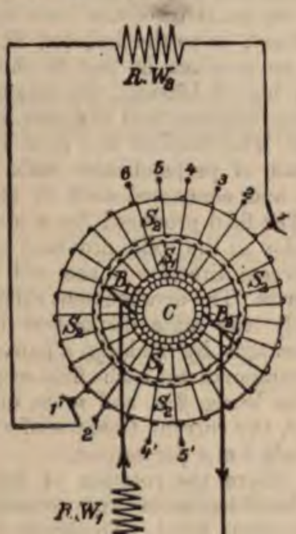
$\rho_1^2 = R^2 + (\omega + \omega')^2 L^2$, and $\rho_2^2 = R^2 + (\omega - \omega')^2 L^2$, which, again, induce in the fixed coil an E.M.F.,

$$\epsilon = \frac{M A}{\omega'}\left[\frac{\omega + \omega'}{\rho_1}(\omega + 2\,\omega')\cos\overline{(\omega + 2\,\omega')\,t - \phi} + \frac{\omega - \omega'}{\rho_2}(\omega - 2\,\omega')\cos\overline{(\omega - 2\,\omega')\,t - \psi}\right].$$

When $\omega' > \omega$, the couple resulting therefrom is positive, and we then transform mechanical energy into electrical energy. When $\omega' < \omega$, the couple, on the contrary, is negative, and the electrodynamic action may be utilised under the form of mechanical energy.

ADJUSTABLE ALTERNATING-CURRENT MOTOR.

In the *Elektrotechnische Zeitschrift* for May 26, Dr. Behn-Eschenburg, of Oerlikon, describes his adjustable alternating-current motor, taking occasion to assert that the motor produced by Mr. Brown, of Baden, is an exact copy of his own, and that the onus of accounting for this resemblance must necessarily fall upon Mr. Brown. Dr. Behn-Eschenburg is careful to point out certain disadvantages of the motors heretofore in use: First, the proportionately great strength of current required when there is no load; secondly, that for a considerable load the current required may be twice as great, or four times as great, as the normal load; and thirdly, that the number of revolutions is limited within narrow bounds, and so also is the load, the result being that the motor turns very little more slowly for full load than for no load, and with a slight increase stops altogether. However, the motor now produced has overcome these difficulties. This motor has been developed from a model which was constructed with the idea of making a series motor for alternate current exactly analogous in construction to the direct-current series motor with collector and brushes. The diagram given will serve to explain the system of construction. The alternate current is carried from the generator through the brushes, B_1 and B_2, to the inducing system, S_1^1, this being formed of an endless iron ring with closed Gramme winding.



For regulating the strength of the current, the resistance coils, R, W_1, can be employed. The primary (exciter) system is arranged similarly to the armature of a direct-current dynamo, forming with the collector, C, the rotating part of the motor. The secondary system is likewise a Gramme winding, S_2, upon a homogeneous iron ring. Now, since, as will be gathered from the figure, the motor is two-poled, there can be no current produced in the closed exterior windings, S_2, unless special connections between suitable points of the winding form circuits in which the sum of the induced E.M.F. is not equal to zero. Such a connection can be effected between any particular points, 1 and 1^1, 2 and 2^1, or 1 and 2, etc. Thus, according to the choice of these connected points the sum of the E.M.F.'s will vary, and therefore the strength of current produced in the circuit. By means of the adjustable resistances, R W_2, in the circuit of the connections, the strength of the current may be varied, while the E.M.F. remains constant.

We observe, also, that by this arrangement the brushes conveying the current always touch the collector at the places that in the direct-current dynamo would be called sparkless or neutral points, and it is found accordingly that in working the machine not the slightest sparking, presenting any difference from that which would occur in a direct-current dynamo, is to be observed. If, however, conversely, we arrange so that the exciting system shall be the exterior, and convert the current at the points 1 and 1^1, or 2 and 2^1, etc., in the exterior system, S_2, and close the induced system, S_1, through the brushes, and the resistance, R W_1, then when the motor is being subjected to a torque, the brushes must be in positions that make a certain angle with the neutral points. Even in this case, however, Dr. Behn-Eschenburg has succeeded in avoiding sparking almost entirely by the use of several very small and independent brushes, but each of which is connected with the one directly opposite.

The latter part of the article is occupied with calculations and theoretical considerations.

ON LIGHT AND OTHER HIGH-FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

(Continued from page 583.)

A form of such discharger with a magnet which has been found convenient, and adopted after some trials, in the conversion of direct currents particularly, is illustrated in Fig. 2. N S are the pole-pieces of a very strong magnet which is excited by a coil, C. The pole-pieces are slotted for adjustment and can be fastened in any position by screws, s_1 s_1. The discharge rods, d d_1, thinned down on the ends in order to allow a closer approach of the magnetic pole-pieces, pass through the columns of brass, b b_1, and are fastened in position by screws, s_2, s_2. Springs, r, r_1, and collars, c, c_1, are slipped on the rods, the latter serving to set the points of the rods at a certain suitable distance by means of screws, s_3, s_3, and the former to draw the points apart. When it is desired to start the arc, one of the hard rubber handles, h, h_1, is tapped quickly with the hand, whereby the points of the rods are brought in contact, but are instantly separated by the springs, r, r_1. Such an arrangement has been found to be often necessary—namely, in cases when the E.M.F. was not large enough to cause the discharge to break through the gap, and also when it was desirable to avoid short-circuiting of the generator by the metallic contact of the rods. The rapidity of the interruptions of the current with a magnet depends on the intensity of the magnetic field and on the potential difference at the ends of the arc. The interruptions are generally in such quick succession as to produce a musical sound. Years ago it was observed that when a powerful induction coil is discharged between the poles of a strong magnet the discharge produced a loud noise not unlike a small pistol shot. It was vaguely stated that the spark was intensified by the presence of the magnetic field. It is now clear that the discharge current, flowing for some time, was interrupted a great number of times by the magnet, thus producing the sound. The phenomenon is especially marked when the field circuit of a large magnet or dynamo is broken in a powerful magnetic field.

When the current through the gap is comparatively large, it is of advantage to slip on the points of the discharge rods pieces of very hard carbon, and let the arc play between the carbon pieces. This preserves the rods and besides has the advantage of keeping the air-space hotter, as the heat is not conducted away as quickly through the carbons, and the result is that a smaller E.M.F. in the arc gap is required to maintain a succession of discharges.

Another form of discharger which may be employed with advantage in some cases is illustrated in Fig. 3. In this form the discharge rods, d d_1, pass through perforations in a wooden box, B, which is thickly coated with mica on the inside, as indicated by the heavy lines. The perforations are provided with mica tubes, m m_1, of some thickness, which are preferably not in contact with the rods, d d_1. The box has a cover, C, which is a little larger and descends on the outside of the box. The spark gap is warmed by a small lamp, l, contained in the box. A plate, p, above the lamp allows the draught to pass only through the chimney, c, of the lamp, the air entering flows through holes, o o, in or near the bottom of the box, and following the path indicated by the arrows. When the discharger is in operation, the door of the box is closed, so that the light of the arc is not visible outside.

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* A lecture delivered before the Franklin Institute, at Philadelphia, February 24, 1893; and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

It is desirable to exclude the light as perfectly as possible, as it interferes with some experiments. This form of discharger is simple, and very effective when properly manipulated. The air being warmed to a certain temperature has its insulating power impaired, it becames dielectrically weak, as it were, and the consequence is that the arc can be established at much greater distance. The air should of course be sufficiently insulating to allow the discharge to pass through the gap disruptively. The arc formed under such conditions when long may be made extremely sensitive, and the weak draught through the lamp chimney, *c*, is quite sufficient to produce rapid interruptions. The adjustment is made by regulating the temperature and velocity of the draught. Instead of using a lamp it answers the purpose to provide for a draught of warm air in other ways. A very simple way which has been practised is to enclose the arc in a long vertical tube with plates on the top and bottom for regulating the temperature and velocity of the air current. Some provision had to be made for deadening the sound.

The air may be rendered dielectrically weak also by rarefaction. Dischargers of this kind have likewise been used by me in connection with the magnet. A large tube is for this purpose provided with heavy electrodes of carbon or metal, between which the discharge is made to pass, the tube being placed in a powerful magnetic field. The exhaustion of the tube is carried to a point at which the discharge breaks through easily, but the pressure should be more than 75 millimetres, at which the ordinary thread discharge occurs. In another form of discharger, combining the features before mentioned, the discharge was made to pass between two adjustable magnetic pole-pieces, the space between them being kept at an elevated temperature.

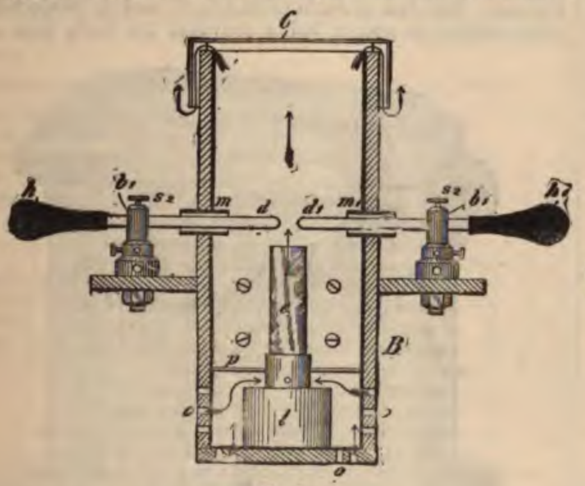


Fig 3

Discharges with Hot-Air Draft.

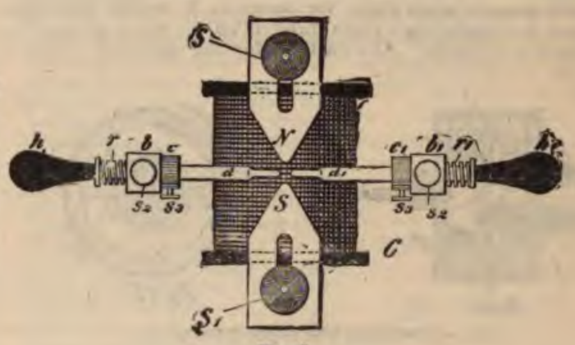


Fig.2

Form of Discharger with Magnet Used in the Direct-Current Conversion.

It should be remarked here that when such, or interrupting devices of any kind, are used and the currents are passed through the primary of a disruptive discharge coil, it is not, as a rule, of advantage to produce a number of interruptions of the current per second greater than the natural frequency of vibration of the dynamo supply circuit, which is ordinarily small. It should also be pointed out here that while the devices mentioned in connection with the disruptive discharge are advantageous under certain conditions, they may be sometimes a source of trouble, as they produce intermittences and other irregularities in the vibration which it would be very desirable to overcome.

There is, I regret to say, in this beautiful method of conversion a defect which, fortunately, is not vital, and which I have been gradually overcoming. I will best call attention to this defect and indicate a fruitful line of work by comparing the electrical process with its mechanical analogue. The process may be illustrated in this manner. Imagine a tank with a wide opening at the bottom, which is kept closed by spring pressure, but so that it snaps off suddenly when the liquid in the tank has reached a certain height. Let the fluid be supplied to the tank by means of a pipe feeding at a certain rate. When the critical height of the liquid is reached, the spring gives way and the bottom of the tank drops out. Instantly the liquid falls through the wide opening, and the spring, reasserting itself, closes the bottom again. The tank is now filled, and after a certain time interval the same process is repeated. It is clear that if the pipe feeds the fluid quicker than the bottom outlet is capable of letting it pass through, the bottom will remain off and the tank will still overflow. If the rates of supply are exactly equal, then the bottom lid will remain partially open and no vibration of the same and of the liquid column will generally occur, though it might, if started by some means. But if the inlet pipe does not feed the fluid fast enough for the outlet, then there will be always vibration. Again, in such case, each time the bottom flaps up or down, the spring and the liquid column, if the pliability of the spring and the inertia of the moving parts are properly chosen, will perform independent vibrations. In this analogue the fluid may be likened to electricity or electrical energy, the tank to the condenser, the spring to the dielectric, and the pipe to the conductor through which electricity is supplied to the condenser. To make this analogy quite complete it is necessary to make the assumption that the bottom, each time it gives away, is knocked violently against a non-elastic stop, this impact involving some loss of energy, and that, besides some dissipation of energy results, due to frictional losses. In the preceding analogue the liquid is supposed to be under a steady pressure. If the pressure of the fluid be assumed to vary rhythmically, this may be taken as corresponding to the case of an alternating current. The process is then not quite as simple to consider, but the action is the same in principle.

It is desirable, in order to maintain the vibration economically, to reduce the impact and frictional losses as much as possible. As regards the latter, which in the electrical analogue correspond to the losses due to the resistance of the circuits, it is impossible to obviate them entirely, but they can be reduced to a minimum by a proper selection of the dimensions of the circuits and by the employment of thin conductors in the form of strands. But the loss of energy caused by the first breaking through of the dielectric—which in the above example corresponds to the violent knock of the bottom against the inelastic stop—would be more important to overcome. At the moment of the breaking through, the air-space has a very high resistance, which is probably reduced to a very small value when the current has reached some strength, and the space is brought to a high temperature. It would materially diminish the loss of energy if the space were always kept at an extremely high temperature, but then there would be no disruptive break. By warming the space moderately by means of a lamp or otherwise, the economy as far as the arc is concerned is sensibly increased ; but the magnet or other interrupting device does not diminish the loss in the arc. Likewise, a jet of air only facilitates the carrying off of the energy. Air, or a gas in general, behaves curiously in this respect. When two bodies, charged to a very high potential discharge disruptively through an air-space, any amount of energy may be carried off by the air. This energy is evidently dissipated by bodily carriers in impact and collisional losses of the molecules. The exchange of the molecules in the space occurs with inconceivable rapidity. A powerful discharge taking place between two electrodes, they may remain entirely cool, and yet the loss in the air may represent any amount of energy. It is perfectly practicable, with very great potential differences in the gap, to dissipate several horse-power in the arc of the discharge without even noticing a small increase in the temperature of the electrodes. All the frictional losses occur then practically in the air. If the exchange of the air molecules is prevented, as by enclosing the air hermetically, the gas inside of the vessel is brought quickly to a high temperature, even with a very small discharge. It is difficult to estimate how much of the energy is lost in sound waves, audible or not, in a powerful discharge. When the currents through the gap are large, the electrodes may become rapidly heated, but this is not a reliable measure of the energy wasted in the arc, as the loss through the gap itself may be comparatively small. The air or a gas in general is, at ordinary pressures at least, clearly not the best medium through which a disruptive discharge should occur. Air, or other gas under great pressure, is, of course, a much more suitable medium for the discharge gap. I have carried on long-continued experiments in this direction, unfortunately less practicable on account of the difficulties and expense in getting air under great pressure. But even if the medium in the discharge space is solid or liquid, still the same losses take place, though they are generally smaller, for just as soon as the arc is established the solid or liquid is volatilised. Indeed, there is no body known which would not be disintegrated by the arc, and it is an open question among scientific men whether an arc discharge could occur at all in the air itself without the particles of the electrodes being torn off. When the current through the gap is very small and the arc very long, I believe that a relatively considerable amount of heat is taken up in the disintegration of the electrodes, which partially on this account may remain quite cold.

The ideal medium for a discharge gap should only crack, and the ideal electrode should be of some material which cannot be disintegrated. With small currents through the gap it is best to employ aluminium, but not when the currents are large. The disruptive break in the air, or more or less in any ordinary medium, is not of the nature of a crack, but it is rather comparable to the piercing of innumerable bullets through a mass offering great frictional resistance to the motion of the bullets, this involving considerable loss of energy. A medium which would merely crack when strained electrostatically—and this possibly might be the case with a perfect vacuum, that is, pure ether—would involve a very small loss in the gap, so small as to be entirely negligible, at least theoretically, because a crack may be produced by an infinitely small displacement. In exhausting an oblong bulb provided with two aluminium terminals with the greatest care I have succeeded in producing such a vacuum that the secondary discharge of a disruptive discharge coil would break through disruptively through the bulb in the form of fine spark streams. The curious point was that the discharge would completely ignore the terminals and start far behind the two aluminium plates which served as electrodes. This extraordinarily high vacuum could only be maintained for a very short while. To return to the ideal medium, think, for the sake of illustration, of a piece of glass or similar body clamped in a vice, and the latter tightened more and more. At a certain point a minute increase of the pressure will cause the glass to crack. The loss of energy involved in splitting the glass may be practically nothing, for though the force is great the displacement need be but extremely small. Now, imagine that the glass would possess the property of closing again perfectly the crack upon a minute diminution of the pressure. This is the way the dielectric in the discharge space should behave. But inasmuch as there would be always some loss in the gap, the medium which should be continuous should exchange through the gap at a rapid rate. In the preceding example, the glass being perfectly closed, it would mean that the dielectric in the discharge space possesses a great insulating power; the glass being cracked, it would signify that the medium in the space is a good conductor. The dielectric should vary enormously in resistance by minute variations of the E.M.F. across the discharge space. This condition is attained but in an extremely imperfect manner, by warming the air-space to a certain critical temperature, dependent on the E.M.F. across the gap, or by otherwise impairing the insulating power of the air. But as a matter of fact the air does never break down disruptively, if this term be rigorously interpreted, for before the sudden rush of the current occurs, there is always a weak current preceding it, which rises first gradually and then with comparative suddenness. That is the reason why the rate of change is very much greater when glass, for instance, is broken through, than when the break takes place through an air-space of equivalent dielectric strength. As a medium for the discharge space a solid, or even a liquid would be preferable therefore. It is somewhat difficult to conceive of a solid body which would possess the property of closing instantly after it has been cracked. But a liquid, especially under great pressure, behaves practically like a solid, while it possesses the property of closing the crack. Hence it was thought that a liquid insulator might be more suitable as a dielectric than air. Following out this idea, a number of different forms of dischargers in which a variety of such insulators, sometimes under great pressure, were employed, have been experimented upon. It is thought sufficient to dwell in a few words upon one of the forms experimented upon. One of these dischargers is illustrated in Figs. 4*a* and 4*b*

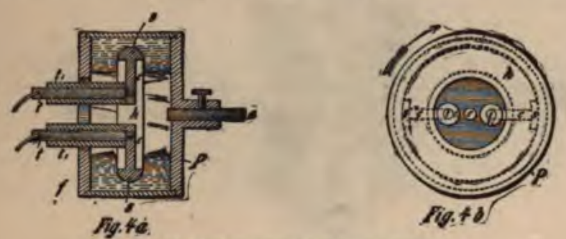


Fig. 4a.

Fig. 4b.

Form of Discharger with Liquid Interrupter.

A hollow metal pulley, P (Fig. 4*a*), was fastened upon an arbor, a, which by suitable means was rotated at a considerable speed. In the inside of the pulley, but disconnected from the same, was supported a thin disc, h_1 (which is shown thick for the sake of clearness), of hard rubber, in which there were embedded two metal segments, s s, with metallic extensions, e e, into which were screwed conducting terminals, t t, covered with thick tubes of hard rubber, t t. The rubber disc h, with its metallic segments, S S, was finished in a lathe, and its entire surface highly polished, so at to offer the smallest possible frictional resistance to the motion through a fluid. In the hollow of the pulley an insulating liquid, such as a thin oil, was poured so as to reach very nearly to the opening left in the flange, f, which was screwed tightly on the front side of the pulley. The terminals, t t, were connected to the opposite coatings of a battery of condensers, so that the discharge occurred through the liquid. When the pulley was rotated, the liquid was forced against the rim of the pulley and considerable fluid pressure resulted. In this simple way the discharge gap was filled with a medium which behaved practically like a solid, which possessed the quality of closing instantly upon the occurrence of the break, and which, moreover, was circulating through the gap at a rapid rate. Very powerful effects were produced by dischargers of this kind with liquid interrupters, of which a number of different forms were made. It was found that, as expected, a longer spark for a given length of wire was obtainable in this way than by using air as an interrupting device. Generally the speed, and therefore also the fluid pressure, was limited by reason of the fluid friction, in the form of discharger described, but the practically obtainable speed was more than sufficient to produce a number of breaks suitable for the circuits ordinarily used. In some instances the metal pulley, P, was provided with a few projections inwardly, and a definite number of breaks was then produced which could be computed from the speed of rotation of the pulley. Experiments were also carried on with liquids of different insulating power with the view of reducing the loss in the arc. When an insulating liquid is moderately warmed the loss in the arc is diminished.

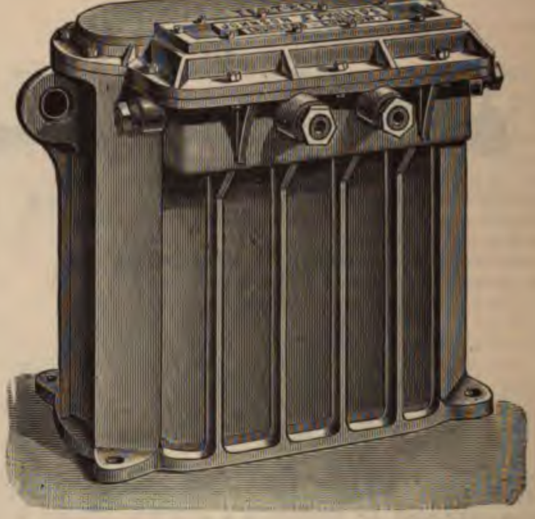
A point of some importance was noted in experiments with various dischargers of this kind. It was found, for instance, that whereas the conditions maintained in these forms were favourable for the production of a great spark length, the current so obtained were not best suited to the production of light effects. Experience undoubtedly has shown that for such purposes a harmonic rise and fall of the potential is preferable. Be it that a solid is rendered incandescent, or phosphorescent, or be it that energy is transmitted by condenser coating through the glass, it is quite certain that a harmonically rising and falling potential produces less destructive action, and that the vacuum is more permanently maintained. This would be easily explained if it were ascertained that the process going on in an exhausted vessel is of an electrolytic nature.

(To be continued.)

TRADE NOTES AND NOVELTIES.

EFFICIENT TRANSFORMERS.

The recent discussion on the efficiency of transformers was expected to lead to the introduction of some new designs. Messrs. Johnson and Phillips are not behindhand in providing a new and efficient type of transformer, and in the illustration herewith we show the appearance of the "J. and P." transformer. The case is made of cast iron, and is perfectly watertight, leading-in glands being provided for both high and low tension wires. This type of transformer is the outcome, we are assured, of considerable experimental work, including the testing of various qualities of iron; and has resulted in a very satisfactory design. The magnetising current is very small, and the drop of volts between no load and full load is considerably less than the old types of transformers. The transformers are being wound for any of the usual voltages and frequencies. The usual sizes will be of the following voltages: 2,400 to 100 or to 50 volts, 2,000 to 100 or to 50, and 1,000 to 100 or to 50. They are made from 1 up to 40 kilowatt capacity—*i.e.*, to supply from 33 up to 1,333 30-watt lamps. A special transformer is also made for working one or two arc lamps on a 100-volt alternating-current circuit.



COMPANIES' MEETINGS.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

Directors: C. L. W. FitzGerald, Esq., chairman; Sir Alexander Armstrong, K.C.B., etc.; Arthur Henry Baker, Esq.; J. H. Buckingham, Esq.; Henry Grëwing, Esq. General manager, Mr. W. J. Milne Menzies. Secretary, Mr. Charles Curtoys.

Report of the Directors presented to the shareholders at the twelfth annual general meeting of the Company, held at Winchester House, Old Broad-street, E.C., on Monday last.

The Directors submit to the shareholders the report and accounts of the operations of the Company for the year ending March 31, 1893, showing a net profit of £4,861. 17s. 10d., which, with the amount carried forward from last year, leaves a balance of £6,228. 6s. 7d. for disposal, after making provision for doubtful debts. Your Directors propose to deal with the amount as follows: To pay a dividend of 2 per cent. for the year on the ordinary shares, and 3 per cent. on the preference shares for the half-year, making 6 per cent. on that class of share for the year; writing off the sum of £357. 18s. 9d. for depreciation of plant, machinery, and furniture; also £63. 16s. 8d. from the cost of new building, and reserving £19. 11s. 9d. for rentals paid in advance, thus leaving a balance of £1,117. 18s. 6d. to carry forward. Resolutions were passed at the extraordinary general meetings on the 9th, and duly confirmed on March 28 last, authorising your Directors to apply to the Court for leave to deal with the funds arising from the liquidation of the securities of the Telephone Company of Austria, and notice has been given to the Company's solicitors that the petition will come before the Court shortly after June 7. The Board regret to state that though the volume of work turned out from the factory has been much the same as last year, the profit has been very much decreased by foreign competitors offering instruments at lower prices. Your Directors have again unanimously resolved to relinquish one-half of their fees for the year ending March 31, 1893. The agencies established have proved fairly remunerative, and the private wire rental business is showing satisfactory expansion. The remaining subsidiary company—the Anglo-Portuguese Telephone Company—in active operation in exchange work, has, considering the state of affairs in Portugal, done very well, the progress being shown by the following statement for the year ending March 31:

Subscribers.		Rental.		Increase.	
1892.	1893.	1892.	1893.	Subscribers.	Rental.
2,139	2,249	£13,640	£14,447	110	£837

The Board deeply regret the loss, by death, of their colleague, Mr. R. Vanzeller. In accordance with the articles of association, the following directors retire by rotation, and, being eligible, offer themselves for re-election—viz., C. L. W. FitzGerald, Esq., and Henry Grëwing, Esq. The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths, and Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31, 1893.

General expenses of management:	£	s.	d.
Including salaries, directors' remuneration, office expenses, stationery, and printing	2,237	9	4
Auditors' fees	105	0	0
Travelling expenses	84	12	10
Income tax on profits	173	13	0
	2,600	15	2
Payments in respect of patents	50	7	0
Expenses in connection with Belgian lawsuit	100	0	0
Expenses in connection with reduction of capital, etc.	25	13	11
Expenses in connection with exhibitions	83	13	8
Balance carried down	4,861	17	10
	£7,722	7	7

	£	s.	d.
Interest on debentures—Telephone Company of Austria	1,086	5	9
Dividend on preference shares—Telephone Company of Austria	906	15	0
Interest on 6 per cent. debentures—Anglo-Portuguese Telephone Company	117	0	0
Interest on 8 per cent. debentures—Anglo-Portuguese Telephone Company	819	0	0
Dividend on shares—National Telephone Company	263	5	0
Dividend on preference shares—Edison Gower-Bell Telephone Company of Europe, Limited	1,500	0	0
Interest (general)	387	0	2
	5,799	5	11
Profit on manufacturing	1,848	9	5
Transfer fees	20	18	6
Income tax returned	53	13	9
	£7,722	7	7

There is also the further sum of £3,000 accrued from the Edison Gower-Bell Telephone Company, Limited, for dividends on preference shares held by us in that company.

Depreciation:	£	s.	d.
Amount written off cost of new building	63	16	8
Amount written off plant and machinery	347	3	5
Amount written off furniture	10	15	4
	421	15	5
Interim dividend on 6 per cent. preference shares	808	0	8
Reserve for rentals—received in advance	19	11	9
Balance carried down	4,978	18	9
	£6,228	6	7

	£	s.	d.
Balance carried down	4,861	17	10
Balance of revenue account from March 31, 1892	1,366	8	9
	£6,228	6	7
Balance	£4,978	18	9

BALANCE-SHEET, MARCH 31, 1893.

Authorised capital:	£	s.	d.
75,000 6 per cent. preference shares of £1 each	75,000	0	0
224,850 ordinary shares of 14s. each	157,395	0	0
75,150 ,, ,, 20s. each	75,150	0	0
375,000	£307,545	0	0
Capital issued:			
27,637 6 per cent. preference shares of £1 each, fully paid	27,637	0	0
224,850 ordinary shares of 14s. each, fully paid	157,395	0	0
	185,032	0	0
Sundry creditors and credit balances	998	16	9
Sundry shareholders for unclaimed dividends and returned capital	154	17	0
Reserve for rentals paid in advance	19	11	9
Revenue account, balance of net profit to date	4,978	18	9
	£191,184	4	3

Capital expenditure:				£	s.	d.
Goodwill, patent rights, etc.*				73,000	0	0
Expenses incurred in the establishment of agencies £304. 6s 11d., less proportion written off for past year, £152s. 4s. 8d.				152	2	3
Plant and machinery, with additions, £5,647. 3s. 5d., less depreciation, £347 3s. 5d				5,300	0	0
Furniture, with additions, £107. 13s. 9d., less depreciation, £10. 15s. 4d.				96	18	5
New building, as per last account, £255. 6s. 8d., less written off, £63. 16s. 8d.				191	10	0
Cost of installation of private lines, £264. 13s. 2d.; less appropriated from rentals received, £21. 8s. 4d.				243	4	10
Stock of instruments, materials, stores, etc.				8,208	15	8
Consignments				78	13	8
Debtors, subsidiary companies, £4,388. 5s. 6d.; agents, £531. 10s. 8d.; other companies and persons, £4,043. 18s. 4d.; total, £8,963. 14s. 6d.; less reserves, £150				8,813	14	6
Bills receivable				259	18	10
Investments in telephone companies—Edison Gower-Bell Telephone Company, Limited, 20,000 preferred shares of £1 each, and 15,000 ordinary shares of £1 each	£16,000	0	0			
Telephone Company of Austria (in liquidation), 3,100 6 per cent. preference shares of £5 each, £15,500; less received from the liquidators on account, £13,175	2,325	0	0			
United River Plate Company, Limited, 1,000 ordinary shares of £5 each at par	5,000	0	0			
Anglo-Portuguese Telephone Company, Limited, £2,000 6 per cent. debentures at cost	1,700	0	0			
Anglo-Portuguese Telephone Company, Limited, £10,000 8 per cent. debentures at cost	10,500	0	0			
National Telephone Company, Limited, 900 ordinary shares of £5 at cost	5,362	14	7			
				40,887	14	7
Cash on deposit—Received to date in respect of debentures and on account of preference shares of the Telephone Company of Austria, Limited (in liquidation)				47,675	0	0
Loans on security				2,100	0	0
Cash at bankers and in hand				4,176	11	6
				£191,184	4	3

* Note.—The Company has conceded patent rights to the Edison Gower Bell Telephone Company of Europe, Limited, and holds in respect thereof the following shares—viz., 174,995 shares of £1 each (£175,995).

On Monday, Mr. C. L. W. FitzGerald (chairman) presided at the twelfth annual general meeting of the above Company, held at Winchester House, Old Broad-street, E.C. The Secretary (Mr. Charles Curtoys) having read the notice convening the assembly,

The **Chairman**, in moving the adoption of the report and accounts, which are given above, said that they were a little late in getting out the report, but that was a question of the auditors. They would observe from the report that the profit for the year amounted to £4,861, which, added to the balance carried forward from the previous year, came to £6,228. They would notice a little lower down that they had passed resolutions at extraordinary general meetings for the payment of a certain sum for the preference shares and the ordinary shares which they had received from the Austrian Telephone Company. That company had paid them a sum of £47,675, leaving £2,325 more to pay them. The reason for the delay in payment of that amount was purely a question of accounts to be settled by the Austrian Company with the Austrian Government. He observed that the meeting had been called that day because they had hoped to have been in a position to inform the shareholders that they had the sanction of the Court to return them that capital. The shareholders would know that in legal matters they could not hurry the lawyers. They had been four months engaged on the matter, and it would require another month to complete it. He then came to a paragraph which he very much regretted—that was, that they were not doing so well in manufacturing as they had been doing. That arose from one cause—he could not say it was due to foreign competition only, but it was also with English firms. The Board were absolutely powerless; they must sell at a reduced quotation, or not at all. It was an absolute fact that the volume of business turned out this year was practically the same as in previous years, but the profit had been reduced from £6.000 to £1,848. All the Directors could do was to manage the business as economically as possible. The whole of the Board were largely interested in the Company. He himself held some 7,000 shares. The Directors were anxious to do well for them, because they were all large shareholders. They would observe that the Board had again given up half of their fees for the benefit of the shareholders, and so far as their agency business was concerned, he thought it was fairly satisfactory, as also was the wire rental branch. Of course, those things at the beginning were very slow, and if it were not for the foreign competition in the market, he thought affairs would be in a satisfactory condition. Their only remaining subsidiary company was the Anglo-Portuguese Telephone Company. It was doing fairly well, and had paid a dividend of 5 per cent. on its ordinary share capital, in addition to paying the Consolidated Company a dividend on the debentures which they held. He was very pleased with the Anglo-Portuguese Company because, although it had been a steady drain on this Company, they were now getting money back. He thought that was very satisfactory. There was not any particular item in the balance-sheet to which he need call attention, except that of expenditure. The expenses had been considerably reduced, and they would next year show a further reduction. He might mention that the amount owing to them was £8,813, whilst they only owed £990 They had a large sum of money in hand and which they hoped to return shortly to the shareholders. He then moved the adoption of the report and accounts and the payment of a final dividend of 3 per cent , making 6 per cent. per annum on the preference shares and 2 per cent. on the ordinary shares for the year ending March 31.

Sir Alexander Armstrong, K C.B., seconded the motion.

Mr. Hibbert felt sure that the Directors had done all they could. There was, however, no account of expenses of manufacturing, and he asked whether manufacturing was carried on at a loss. The question was whether it was worth while for the Company to go on.

The **Chairman** did not like to be a prophet, but he hoped they would do better in future. Foreign competition had proved to be more than he had thought. If only the manufacturing and only the expenses on the other side were considered, they were working at a loss.

The motion was then put to the meeting, and was unanimously adopted.

On the proposal of **Mr. J. H. Buckingham**, seconded by **Mr. A. H. Baker**, the Chairman and Mr. H. Grëwing were re-elected chairman and director respectively.

Some discussion then took place as to the advisability of having two auditors, and eventually Mr. J. G. Griffiths was appointed, Mr. A. E. Green not being re-elected.

A vote of thanks to the Chairman brought the proceedings to a close.

ELMORE'S WIRE MANUFACTURING COMPANY.

An extraordinary general meeting of the shareholders in Elmore's Wire Manufacturing Company was held on Monday at Winchester House, Old Broad-street, under the presidency of Mr. J. J. Atkinson.

The **Chairman** said that the report of the committee of investigation appointed by the general meeting of the shareholders was issued in April last. From that report they were able to gather that if the working capital required was subscribed there was every prospect of success for the Company. The Board and committee jointly made an issue of £25,000 of 6 per cent. first mortgage debentures, which, however, were insufficiently subscribed, The Board, therefore, called together nearly 100 of the largest shareholders of the Company, and laid before them a scheme, which was contained in the circular of May 31, and which commended itself to them for adoption. The provisional applications, however, for the preference shares up to the present time were comparatively few, and this fact had compelled them to open up further negotiations with other parties for the advance of the sum required to relieve the Company of its liabilities, amounting to £15,000. To carry out these negotiations, however, it was stipulated that the Board should get the additional capital required, and for that purpose he proposed the following resolution, of which notice had been given: "That 16,500 unissued ordinary shares of the Company be issued, and be called preference shares, entitling the holders thereof to a cumulative preference dividend of 10 per cent. per annum and to one-half of such remaining profits of the Company in each year as shall be applicable to the payment of a dividend on the capital paid up on the shares of the Company other than the founders' shares; the said preference shares shall be entitled to priority not only as to dividend but also as to capital on a distribution of assets.

The resolution was carried, with one dissentient, after considerable discussion.

NEW COMPANIES REGISTERED.

Merionethshire Electric Lighting, Power, and Appliance Company, Limited.—Registered by Jordan and Sons, 120, Chancery-lane, W.C., with a capital of £3,000 in £1 shares. Object: to carry into effect an agreement, made May 26, between A. Hall and Co. of the one part and F. H. Hardy on behalf of this Company of the other part, and to carry on the business of an electric light and power production and supply company at Dolgelly, Merionethshire, and elsewhere.

Pioneer Electric Carriage Company, Limited.--Registered by Renshaw, Kekewich, and Co., 2, Suffolk-lane, E.C., with a capital of £20,000 in £50 shares. Object: to develop traction and propulsion of vehicles or carriages on tramways, highways, and roads by means of electricity, and, with a view thereto, to carry into effect an agreement made with the Electrical Power Storage Company, Limited. There shall be not less than two nor more than seven directors; the first are to be elected by the signatories to the memorandum of association. Qualification, £100. Remuneration to be fixed by the Company in general meeting.

BUSINESS NOTES.

Islington.—An electrical engineer is required by the Vestry of St. Mary, Islington. Particulars as to duties, etc., will be found in an advertisement on p. xvi.

West Ham.—On Tuesday night, the West Ham Town Council adopted the report of a committee in favour of a scheme for lighting the streets by electricity.

Personal.—Mr. Reginald S. Wallis-Jones, A.M.I.C.E. and M.I.E.E., has joined the staff of Messrs. Kincaid, Waller, and Manville, consulting engineers, of 29, Great George-street, Westminster.

Western and Brazilian Telegraph Company.—The receipts of the Western and Brazilian Telegraph Company for the past week, after deducting 17 per cent payable to the London Platino-Brazilian Company, were £2,768.

Yeadon.—At the meeting of the Yeadon Local Board last week it was decided to accept the offer of Messrs. Andrews and Preece, Bradford, to furnish an estimate, free of cost, of a scheme of lighting Yeadon by means of electricity.

City and South London Railway Company.—The receipts for the week ending June 11 were £759, against £745 for the same period last year, or an increase of £14. The total receipts for 1893 show an increase of £1,638 over those for the corresponding period of 1892.

Japan.—We learn that over a dozen electric light companies have already been started in Japan, and that others are being formed. It is stated that the Japanese War Department have arranged to adopt electric lighting on the coast fortifications, for use in time of war.

Blackpool Trams.—The electric trams are running better, and breakdowns have been less frequent. If a further installation of electricity in the town can improve the service, it is hoped this will be soon. There is a movement for starting the running of the trams on Sunday.

Lighting of Monaco.—The Administrative Council of Monaco has decided to introduce the electric light in the most important thoroughfares. About 300 arc lamps of varying candle-powers are to be put up, and Messrs. Schuckert and Co. are carrying out the installation, which is to be in operation in October.

Newcastle Olympia.—A huge building, to be called the New Olympia, is to be erected for public meetings at Newcastle The building will be lighted by gas and electric light, and all work throughout will be carried out to the satisfaction of the city engineer. The architects are Messrs. Oliver and Leeson.

Hanley.—Out of 64 applicants for the post of electrical engineer to the Hanley Town Council, the General Purposes Committee selected four, who appeared before and were questioned as to their qualifications and experience by the Council. Mr George H. Cottam, of London, was appointed at a salary of £200 a year.

Oswestry.—The Town Clerk of Oswestry, at the last Town Council meeting, said that a special meeting of the General Purposes Committee, held on June 2, had agreed to sanction the application of the Oswestry Electric Lighting Company, subject to certain terms and the matter would be discussed at a special meeting of the Council on July 3.

Swan United.—The Directors of the Swan United Company have resolved to pay an interim dividend at the rate of 5 per cent. per annum in respect of the six months ended March 31, 1893, as follows: 1s. 9d. per share on the 78,949 ordinary shares of the company, £3. 10s. paid; and 2s 6d. per share on the 19,750 £5 fully-paid shares, free of income tax. The interim dividend will be paid upon the register as it stands this day, and the warrants will be issued on the 20th inst.

Consolidated Telephone Company.—This Company cannot boast of a very flourishing concern. Its balance-sheet, indeed, shows a profit of £4,861, but of this only £1,848 is from manufacturing account, while £2,713 has been received from a source which has run dry, though it may be that other sources have not yet been tapped to their fullest extent. We should like to see the income from manufacturing higher, the Directors getting full fees, and less dependence upon subsidiary companies.

e-street.—We understand that Messrs. Maw, Son,
son are adopting an installation consisting of a
horse-power Crossley engine, dynamo, and E.P.S. cells,
ing of their extensive premises in Aldersgate-street,
he arrangements will be very complete. Mr. W. H.
M.I.M.E., of London and Bristol, is consulting
the work.

d of Kinsale Lighthouse.—Evidence respecting the
t in comparison with the new gas light, recently
Dublin Bay, was laid before the council of the Dublin
Commerce on Monday and directed to be sent to the
ade, for the information of that Board. This was in
of the previous communication to the Board and to
se authorities sent by the Chamber expressing their
o the improvement of the light at that station.

elephones.—At a meeting of the Cardiff Public Works
held last week, the borough engineer reported that he
l a communication from the National Telephone Com-
ing him that that company intended laying about 100
phone wire in the town, and asking whether it would
le to have the wires overhead or underground. The
nstructed Mr. Harpur to reply stating that the under-
n would be preferable. This was all the business of
est.

th.—At the quarterly meeting of the Portsmouth
cil last week a certificate was received from Messrs.
Manville for the payment of £700 to the contractor for
of the electric lighting station in Gunwharf-road, on
work executed, and the committee recommended that
00 be paid to the engineers, Messrs. Garnett, Waller,
lle, on further account of their commission, making,
vious payment of £200, one-third of the commission
e paid. The recommendations were adopted.

.—A Bill to confirm certain provisional orders made by
of Trade under the Electric Lighting Acts, 1882 and
on Thursday last week as an unopposed measure before
chairman of Ways and Means, in the House of Com-
ong others was one enabling the Corporation of
supply electrical power within the municipal borough
n of the district of the Taunton Rural Sanitary Authority.
ofs having been given on behalf of the Board of Trade,
s allowed to pass through the committee stage, and in
it will be reported to the House for third reading.

.—At a meeting of the Tiverton Town Council on
last week, an interesting letter was read from Mr.
suggesting means for introducing the electric light at
ithout burdening the rates. He asked if those who
use of the light were able to form a guarantee society
ugh to undertake the responsibility and pay 9d. per
next three years, would the Council undertake the
would vote for it and think the money well spent. He
to join the guarantors and take the light at Hensleigh.
was favourably received, and referred to the Electric

.—An enquiry by Mr. T. Codrington, an inspector of
Government Board, was held on Wednesday into an
of the Town Council for sanction to borrow £8,200 for
f electric lighting. Mr. Boxall, who represented the
, stated that two loans—of £32,500 and £8,500 respec-
been sanctioned, and an enquiry had been held in
third loan (for £37,700), but owing to certain modifi-
the original plans and estimates which were found
he total excess of expenditure on the first two loans had
2. 13s. 8d. The present application was for sanction to
ver this additional outlay. There was no opposition.

ns.—At the St. Albans City Council last week, Coun-
nin gave notice that he would move at the next meeting
nittee be appointed to consider the matter of the better
the town. At Chelmsford, where he had been staying,
most successful system of electric light, and the Wat-
rities were taking the matter up. Considering the
of their Cathedral and of St. Peter's Church, it would
reat thing for the Corporation to get the lighting of the
ir own hands for the future, and to follow the example
ot only in England, but throughout the colonies and
world. He was not a gas company shareholder, and he
e the courage to move a resolution on the subject at the
g.

ne Companies and Electric Traction.—The Joint
of the Houses of Lords and Commons sat on Monday
the course of procedure in relation to the arrangement
e clauses for telephone and other companies against the
of electric railways and tramways. Lord Cross was
irman, and the committee decided to sit *de die in diem*
ay next, Saturdays excepted. It was decided to admit
resenting the Railways Association, the National Tele-
pany, electric tramways and railways, electric lighting
and the municipalities of England and Scotland, in-
London County Council. At the first meeting of the
Sir Courtenay Boyle, K.C.B., permanent secretary of
of Trade, will be examined.

hting.—Mr. Altman asked the chairman of the Com-
Sewers at last week's meeting whether in the contract
o with the City of London Electric Lighting Company
on was made with reference to the supply of private
Mr. H. H. Bridgman replied that the contract re-
arily to public lighting, but there was a clause pro-
the contractors should within a reasonable time supply electricity to private consumers within a certain distance of their mains, and that after the expiration of 18 months they should lay down sufficient mains to enable them to do so on a requisition being signed by six or more owners of property. Failing this the company were liable to a penalty of 40s. a day. Mr. Richardson followed this up by a complaint that the paving had been taken up for the second time in Liverpool-street and still remained up.

Dachet.—The electric light installation which has been laid down at the Manor Hotel, Dachet, near Windsor, by Messrs. Roger Dawson, Limited, under the superintendence of Mr. A. E. Farrow (now resident engineer of the Windsor Electric Light Company) as consulting engineer, has at length been completed, and has started running. The plant comprises a Crossley's "Otto" gas-engine (horizontal type) indicating 6 h.p., which, obtaining the gas from the Slough Company's gas-mains, drives a "Taunton" dynamo of the latest pattern, having a capacity of 30 amperes at an E.M.F. of 65 volts. There are 27 E.P.S. accumulators, 15 lamps, and the dynamo is fitted with two flywheels, to run in parallel with the cells if necessary. There are, further, an ammeter in the charge and an ammeter in the discharge circuit, a voltmeter to show the E M.F. on the dynamo circuit, as well as at lamps, with two-way switch, and an automatic excess-current alarm, solenoid type, by which arrangement if more than 30 amperes are taken from or put in the accumulators, a warning bell rings. This plant supplies 72 8-c.p. lamps.

Printing Telegraph Company Havas.—The statutory meeting of the Printing Telegraph and Construction Company of the Agence Havas was held on Wednesday, Colonel W. J. Engledue in the chair. The chairman said that the Directors proceeded to allotment on 12,177 shares, representing £60,885, but several subscribers failed to pay, and the agreement to pay the inventor £7,000 in cash and a proportion of fully-paid shares fell through. However the Directors acquired the patent from another source without payment of cash. It is thought the attempt at wrecking the Company emanated from rivals to the Agence Havas in Paris. A list was shown giving the names of 66 subscribers, paying in all a yearly rental of 105,700f. There will be established 125 machines in 10 circuits. Mr. C. Cammell resigned his seat on the Board, and Count Max Hollender took his place. Sir Augustus Harris was also appointed a director. The cost of the 125 machines and laying cables would be £10.000, and it was proposed to call up £1 per share at once and £1 in two months' time. A vote of thanks to the chairman concluded the proceedings.

Woodhouse and Rawson.—Mr. F. D. Leslie, receiver and manager, writing from 88, Queen Victoria-street, says: "Having had numerous enquiries as to whether the business of Woodhouse and Rawson United, Limited, is still being carried on, I take this opportunity of informing you that it is, and will be continued, under my personal supervision, as receiver and manager on behalf of the debenture-holders of the Company. I also beg to inform you that, with a view to centralising the business, I am, with the exception of Glasgow, Birmingham, Bradford, Manchester, and Kidsgrove, closing all other branches throughout the United Kingdom. This will enable the head office to keep in direct touch with the numerous customers of the Company and avoid that delay which must necessarily be caused by correspondence between the branches and the head office. The works at Manchester have recently been enlarged by new machinery, etc., having been put down, and I am pleased to say that the Company is now in a position to turn out work thoroughly and promptly." The Company, he adds, are open to quote or submit samples with a view to the fulfilment and continuance of orders.

Bowness.—At the last meeting of the Bowness Local Board, a letter was read from Mr. Fowkes, as representative of the electric lighting company, relative to the erection of an extra lamp near The Green, on Rayrigg-road, and setting forth that the net cost of laying the cable and fitting lamp would be £18. 10s. The Chairman said it had been considered in committee, and was thought a somewhat heavy charge. The Clerk stated that Mr. Fowkes was bound by agreement as to street-lighting, and, referring to the agreement, read the clause whereby Mr. Fowkes undertook to light the whole of the district street lamps for two years at a cost of £80 per year, and to pay one-half the cost of refitting lamps for the purpose, the Board to pay the remaining half. Mr. Harrison considered it quite time something should be done to get the street-lighting into operation, which had been promised for May 20. It seemed as though the hotel contracts were more beneficial to the light producers, as these places had been regularly lighted for some time back. Mr. Brockbank proposed that the clerk be instructed to write to Mr. Fowkes, requiring him to have the arrangements for lighting street lamps completed by the end of June, which was unanimously agreed to.

Sheffield—The Parliamentary Committee of the Sheffield City Council have considered a letter from Mr. T. Scott-Anderson, 59, Wilkinson-street, Sheffield, asking whether the Corporation would be disposed to consider an application from a satisfactory local syndicate for their consent to parliamentary powers being sought for the establishment of an electric supply company, to supply electric current for public use in the Broomhill and Ranmoor district. A letter has also been received from Mr. S. E. Howell, stating that he was getting out particulars of a scheme for electrically lighting the Ranmoor district, which he wished to lay before the committee before they came to a conclusion on the application of Mr. Scott-Anderson. It was resolved: "That this committee are not indisposed to consider any applications for the consent of the City Council to powers being obtained for the supply of electricity within the limits of the city, and that Mr. Scott-Anderson and Mr. Howell be requested to furnish details of their respective syndicates or schemes, and the areas they propose to supply." It was decided to inform the Sheffield Electric Light and Power Company of these applications, to give them an opportunity of making observations thereon.

Moffat.—At the meeting of the Moffat Town Commissioners, Mr. Brown submitted a report by Messrs. Woodhouse and Rawson, electrical engineers, Glasgow, with respect to the lighting of the town with electric light. The report stated that by using the water power obtainable at the waterfall at Skellywell, on the Evan, sufficient power would be got to light the streets of the town by 2,000-c.p. arc lamps, and leave to be sold to private persons light estimated to be worth over £1,900 a year. The current would be conveyed for the first mile and a half through the fields by overhead wires, and for the last half mile by wires laid in pipes along the public road, the same method being followed in distributing the current through the town. The estimated cost for the works, exclusive of those required in the distribution to private houses, was stated as likely to be a little over £4,000. The report was left for consideration at next meeting.

Liverpool Overhead Railway.—The directors of the Liverpool Overhead Railway Company, in order to meet the general demand for the equivalent of contract tickets on other railways, have decided to sell books of tickets at a reduction of 10 per cent. on amounts over £1. This will prove both convenient and economical to passengers travelling daily on the railway, and to firms who have to send their employés frequently along the line of docks. Special reduced fares will also be arranged for large parties of excursionists. The success of the railway is now fully established, nearly a million and a quarter passengers having been carried since the opening. The trains have been run with great punctuality, as since the opening an average of 93 per cent. have been run up to time. The attention of the directors having been called to the fact that the carriages were not sufficiently ventilated, a trial train has been fitted up with new ventilation arrangements, which, having proved satisfactory, the directors have given orders for the whole of the trains to be ventilated in a similar manner.

Burnley.—Another few weeks will see the completion of the electric light station at Burnley. Nearly two miles of street main are laid in the principal thoroughfares. A box at Bull Corner is the main distributing point. The building is of red brick, lofty and roomy, and will be a singular contrast to its not altogether inviting surroundings. The engine-room is very commodious. The foundations for the two engines and machinery are completed, and there is ample space for a third set should the demand for electricity so increase as to render an extension necessary. The travelling cranes are in position, ready for the fixing of the dynamos. The setting of the boilers is nearly finished, the economisers are in position, a large square chimney is gradually showing itself, and the roofs of the building are receiving the finishing touches. The river is conveniently near at hand for supplying the boilers, which have been furnished by the Oldham Boiler Company, and will be fitted with Proctor's patent stokers. The Electric Construction Corporation, of Wolverhampton, have the contract for the dynamos, electrical fittings, and accumulators, Green has supplied the economisers, and the Callender Company the cables. A large arc light is to be placed at the obelisk in St. James's-street, and the Corporation may probably erect a few more lamps at busy corners. It is expected that the light will be eagerly taken up by the residents and shopkeepers.

Newport.—At the monthly meeting of the Newport Free Library Committee the Mayor stated that the Corporation had committed themselves to electric lighting, and that it was only a question of time and of what system should be adopted. He imagined that the library would be one of the first institutions to adopt the electric light, because the books in the lending department would be thereby preserved. Mr. Burgess Hughes said that the heat generated by the gas was at present rotting the buildings. Mr. G. H. Llewellyn, solicitor, who has had a considerable experience in electrical matters, has been discussing the scheme for lighting the town of Newport by means of electricity. He thinks, instead of the low-tension continuous-current system which, it is presumed, will be adopted by the Corporation, who are committed to the new illuminant, the system which appears to him as the best for the economical distribution of electrical energy over large areas is the high-tension continuous current generating 1,000 volts at a central station, and transforming to 100 volts by means of motor dynamos at suitable sub-stations. The system has been tried with success at other places, notably Nottingham and Oxford. It would be prudent to allow a company to supply the plant, and after they have made the project a success transfer to the Corporation their undertaking upon being reimbursed their proper outlay capitalised at 5 per cent.

Whitehaven.—The Whitehaven Town and Harbour Trust have affixed their seal to a bond to the Cumberland Union Bank for £1,500 on electric lighting capital account. At the last monthly meeting, the minutes of the Electric Lighting Committee stated that on May 24 the surveyor was instructed to communicate with Dr. Hopkinson with reference to the preparation of rules and regulations for installations to private houses. The surveyor submitted plan for accumulator-room, and was instructed to advertise for tenders for erection of same. On May 31 tenders were opened and considered for accumulator-room at the electric light station from Mr. R. S. Cousins, Mr. Jonathan Young, and Messrs J. S. and J. Glaister, and it was recommended that the tender of Messrs. Glaister, being the lowest, be accepted. The Chairman, in moving the confirmation of the minutes, said that the work generally with regard to electric lighting was progressing very satisfactorily. Somewhat over a mile of the main had been laid, and although at the commencement of the work the progress was slower than they expected it to be, the men were now getting accustomed to the part of the work which had been new to them, and he had no doubt they would get the work well advanced, if not finished, by July 1, when the term mentioned in the contract ended. The contract for the building of the accumulator-house had been let, and the tenders for the accumulators themselves were to be in on Wednesday, so everything in connection with the light was in a fair way of progression. Mr. Hastwell seconded the motion, and it was agreed to.

Burnley Town Hall.—The preliminary arrangements for lighting the Burnley Town Hall with the electric light are now practically completed. Over four miles of wire have been used in this installation. The work has been done thoroughly and satisfactorily under the supervision of Mr. Edgar H. Berry, A.Inst.E.E. (district manager for Messrs. J. E. Spagnoletti and Crookes, of London, Burnley, and Sheffield). Every room, from the banqueting-room at the top to the police cells at the bottom, will be lighted. Throughout the building there are 241 switches and 207 ceiling roses (apart from fittings), and some 400 lamps will supplant the gas. The system is divided into two circuits—one for the Town Hall, and another for the police department. Each has a main switchboard, and there are nine distributing boards with the various circuits running from them. Special attention has been paid to the suite comprising the Mayor's parlour, the reception-room, the Council-chamber, and the landings. In all other parts of the buildings the wires are carried in outside casings, here they are placed inside the walls, and the switchboard has been removed to an out-of-the-way place in order that nothing incongruous may disturb the elaborate decoration which the rooms are receiving. As showing the attention which has been paid to every detail, it may be mentioned that provision has even been made for an electric cigar lighter in the smokeroom. The work in the large police court will comprise four eight-lamp electroliers, in place of the large gas standards, in addition to several standards on the magistrates' bench. If, as is hoped, the current can be transmitted from the electric lighting station within six or seven weeks, the Town Hall will probably be the first building to use the illuminant.

Birmingham Central Tramways.—The following clear letter to the editor of the *Daily Post*, from Mr. Joseph Kincaid, 37, Waterloo-street, Birmingham, engineer to the Birmingham Central Tramways, will be read with interest at the present state of electric traction: "Sir, my attention has been called to a statement in the Shareholders' Association report of the 2nd inst. that the directors were advised against the expenditure which they incurred for working the Bristol-road tramways by electricity, and to the letter, of the 5th inst., published by my colleague Mr. Pritchard, contradicting that statement. I think it is due both to the directors and to the engineers of the Birmingham Central Company that some fuller explanation should be made in this matter. In 1888-9 the directors had to decide how the traffic of the Bristol-road should be worked. They could not, for very sufficient reasons, adopt either horses, or steam-engines, or electricity by overhead wires, and they had to choose between the cable system or the accumulator system. The experience obtained of cable traction showed that the cost of applying it to the Bristol-road would be about £80,000, which would be about £40,000 more than the estimated cost of the accumulator system. It was, therefore, necessary to consider, first, whether the traffic which was then estimated to be available on the Bristol-road would justify an additional capital expenditure equivalent to, say, £2,000 a year; and, secondly, whether the company were in a position at that time to raise such a large sum as £80,000 for this purpose. These questions the directors considered very anxiously; and in view of the rapid improvements being then made in electric traction they decided to adopt the system, not only as having a smaller first cost, but one which did not involve the large expenditure on tramway construction which is special to the cable system."

Southampton.—A three-ton electric crane is now in regular work on the town quay, unloading the vessels of the Clyde Shipping Company as they come in, and the second crane will be erected very shortly, being now almost complete. The maximum speed of lifting of the crane is 200ft. per minute, and by the specification the slewing is to be 400ft. per minute; on test, however, the crane slewed at the rate of 520ft. per minute. The motors are capable of regulation to lift and slew at any speeds less than the maximum above stated. For lifting, a Statter motor, absorbing 200 volts and capable of passing 225 amperes, and making 600 revolutions per minute, is used. This motor runs continuously, and drives through worm and worm wheel, the former running in an oil bath. In regular work, lifting 10cwt. to 20cwt. loads, the average current taken by this motor is about 50 amperes. To lift and lower, the worm wheel is put in and out of gear with the barrel by means of a Lindsey transmitter, worked by a lever placed on the driving platform. On this platform there are three levers. The one to the transmitter for lifting and lowering is worked by the driver with his right hand. On his left there is a similar lever, which works the combined reversing and regulating switches controlling the slewing. Also on his left is another lever working a similar switch for the lifting motor. This latter switch is introduced on account of the well-known fact that all mechanical clutches, however well they may work as a rule, are liable to become jambed, and accidents frequently happen with steam-cranes from this cause With this crane, should the transmitter stick, the driver can at once stop his motor by the switch. Sparking at the switch, both for lifting and lowering and for slewing, is taken up between two carbon points, and there is no appreciable sparking on the switch contacts themselves. These switches are so arranged that the movement of the lever follows to some extent that of the load, and it is therefore easy for the driver to recognise from the position of his load what movement he should make with his lever. To lift his load the switch is driven forward, and to lower it is pulled backward. The middle position, which is determined by a click catch, is the position of rest. For the slewing motion the mid position of the switch corresponds with the position of rest, and forward or backward, to right hand or left hand, slewing is marked by arrows. A powerful band brake is provided, and operated by a foot lever, and in addition there is a magnetic brake which acts and holds the load in case the supply of current to the crane should cease at the moment that the load is being lifted. The slewing motor works at an E.M.F. of 200 volts, and has a capacity of 50 amperes. The average current required to slew is from 15 to 20 amperes. The current for driving the cranes is supplied by the Southampton Electric Light Company, and is fed through special mains laid down along the quay to a pair of overhead conductors of silicium bronze wire. The current from these is collected by two clamping blocks which are arranged in the gantry. These grip the conductors firmly, the pressure being supplied by a screw. The same action locks the travelling gear of the crane, and renders it impossible for the crane to be moved until the clamps have been slackened on the conductors. This gear is controlled by a hand-wheel which is easily accessible from the top platform of the gantry. The current is led from the clamping blocks in a hard wood channel to the centre pivot of the crane. The pivot is of steel, and is bored through to carry the leads. On the head of the crane-pin a pair of collector rings are placed, and from them the current is led to the switchboard. This switchboard, which is additional to the starting switches before described, is fixed in the cabin on the left-hand side of the driver. It contains an ampere-meter, and the main switches and fuses for the lifting and slewing motors, together with switches for six lamps which are employed to light the crane cabin and to throw light upon the loads. The lamps for the latter duty are fixed in a reflector attached to the jib. The cranes have been constructed to the specification of Mr. J. G. W. Aldridge, the electrical engineer to the Harbour Commissioners, by Messrs. Statter, working in conjunction with Messrs. Stothert and Pitt, to whom was entrusted the building of the gantries and the crane gearing.

Cork Tramways.—At the meeting of the Standing Committee of the Cork Town Council last week the scheme for an electric tramway was sanctioned. Mr. Giltinan read the following report on the tramway scheme from Mr. M. J. M'Mullen, the city engineer: "I beg to report that in accordance with your instructions I have had a conference with Mr. Fraser, engineer to the Cork Tramway Company, with reference to the application of the company for the sanction of the Corporation to the amendment of the original scheme by the substitution of electricity for horses as the motive power. As regards the motive power, the company propose adopting the system of overhead wires, and they urge, and with great reason, that the underground system would be unworkable in this city, owing to the low level of the principal streets, and the sanitation of the subsoil by the tidal waters, which were in some instances to within 6in. of the street-level. Mr. Fraser has pointed out to me the various places in which it is contemplated that the posts should be placed—some in King-street, adjoining Ship-street, and in Patrick-street, from the Mathew Statue to Princes-street. The promoters propose that these posts shall be placed at either side of the street, about 20ft. apart. But in the portion of Patrick-street and King-street I have mentioned, they intend placing them in the centre of the roadway. Mr. Fraser has also informed me that it was intended that the maximum potential of the current through the head wires should be 500 volts, and this I do not consider excessive, or in any way attended with danger to the workmen and others who may come in contact with the wires whilst charged with electricity. The great objection to the overhead system is that in many places the wires are placed at such a low level as to prevent the passage of a fire escape through the streets. Another objection is that the posts in some instances obstruct the footways, and are of an unsightly appearance. If these objections are got over, and if the maximum potential be limited to 500 volts, I see no reason why the committee should withhold their sanction from the proposed amendment in the scheme, but such sanction should not, in my opinion, be granted, save upon the following terms: (*a*) The maximum potential of the current should be limited to 500 volts; (*b*) the wires should, under no circumstances, be fixed at a lesser height from the roadway than 24ft.; (*c*) The poles should be ornamented in structure, of a design to be approved of by the Corporation, and made of cast or wrought iron; (*d*) no poles should be permitted to be erected in Marlborough-street, but the promoters should, in view thereof, be allowed to use wall brackets, subject, of course, to their obtaining the consent of the owners of the houses upon which brackets may be placed to the erection of the brackets; (*e*) the positions of the several poles should be subject to the approval of the city engineer; (*f*) the promoters should undertake to permit the Corporation, in case they should at any future time undertake the lighting of the city by electricity, or any company who should undertake the public lighting by agreement with the Corporation, to use for that purpose any poles or brackets which may be erected by the tramway company." Mr. Hungerford asked whether it was agreed that the Corporation should get possession of the poles from the tramway company when they should at any time decide on lighting the city by electricity. Mr. J. Walter Bourke, solicitor (who appeared on behalf of the tramway company), said this was so, and that by using the electricity as the motive power, they would be promoting further work in the city. The report of the engineer was conformable to the arrangements which Mr. Fraser, engineer to the company, had entered into with Mr. M'Mullen. In Marlborough-street they should use small brackets on the houses instead of poles. Sir John Scott asked would the Corporation receive any rent in return for allowing the tramway company the use of the streets? Alderman Horgan said that they ought to be very well satisfied when they are getting over three miles of streets block paved by the company. Sir John Scott said there were now so many posts erected through the city that really the Corporation should receive some recompense. Mr. Keatinge then moved that the application be granted, provided that the conditions suggested by the city engineer in the report should be complied with. Mr. Rahilly seconded the motion. After discussion, on the motion of the Mayor it was unanimously decided to grant the permission to construct the main line. Mr. Keatinge's motion was then withdrawn. The Mayor moved as a further amendment that permission should be granted to the Board to substitute electricity for horse power as the motive force, and that the words relating to the Marlborough-street part of the scheme should be omitted. This was carried by the chairman's casting vote. The Mayor was astonished that there should have been so much opposition. It was surprising that they would not all accept the block paving of over three miles of the streets, from the Great Southern and Western Railway to the Muskerry terminus. Mr. Bourke thanked the committee on behalf of the Board. The chairman was glad the scheme had been passed, and he hoped they would begin at it at the earliest opportunity. Alderman Horgan said he was sure they would.

Stafford.—At the monthly meeting of the Stafford Town Council, the Electric Lighting Committee in their report stated that pursuant to the order of the Town Council of December 6, 1892, they had obtained from Mr. Bell a very able and exhaustive report as to electric lighting for the borough, but before submitting a scheme to the Council, they recommended that they should be empowered to submit Mr. Bell's report to an electrical engineer, and obtain his opinion upon it, and they asked the Council to authorise them to expend such sums of money as might be necessary for the purpose of obtaining such an opinion, and defraying all other expenses of preparing a scheme. The committee added that Mr. Bell himself was desirous of having his views and recommendations considered and reported upon by an electrical engineer of acknowledged position. Alderman W. H. Peach moved the adoption of the report, and explained that the committee had decided upon this course after very careful consideration, as they felt it was imperatively necessary that the greatest care should be exercised by the Council before committing themselves to what might, if not well considered, prove a disastrous failure. In electric lighting, there was no best system. What was the best system for one place was not the best for another place. In some towns high tension was required, and in other towns low tension was more desirable. It was in order that no possible mistake might be made that the committee asked the Council to sanction the appointment of an electrical engineer. They were not casting the least doubt upon the report they had already received. They had the highest opinion of Mr. Bell's ability, both as an electric and a gas engineer, but in order that everybody might be satisfied that the proper thing was being done, they asked the Council to sanction the course recommended by the committee. Mr. Wormal seconded the adoption of the report. Mr Johnson urged that the Council should have some idea given to them of the scheme that was to be submitted to the expert. He asked if the Council would be in any way pledged to the scheme as to the area of the electric lighting or the expenditure. Mr. Gibson considered that the report ought to be in the hands of every member of the Council. He contended that the main streets were as well lighted as there was any need for, and that nothing was to be gained by the electric light, while it might land them in an expenditure of from £30,000 to £35,000. Some importance was attached to the fact that the light was wanted for the new County Council buildings, but he pointed out that the County Council did its work in the day time, and that the offices would not be open at night. He moved "That the discussion be adjourned for one month, and that in the meantime the report be placed in the hands of the Council." Alderman Lloyd seconded this amendment. While he believed that the electric light was the light of the future, he thought this matter had come upon them at an unfortunate time, when they were compelled to deal with a question of great importance to the health of the town in the sewage scheme. He pointed out that Birmingham, with all its great resources, and making its own gas, had not opposed the introduction of the electric light by a company, while at Leamington the adoption of the electric light by the Corporation had been a total failure in the public streets. He also urged that as the electric light at Stafford was to be confined to a certain area of the town, the Council were legislating in this matter only for a few. The Town Clerk, replying to Mr. Johnson's question, said the Council would not be committed in any way whatever by the expert's report. The Mayor, also replying to Mr. Johnson, said there was an estimate as to the expenditure, but it was merely an estimate, and might be modified in any way or the expert might veto the whole scheme. Alderman W. Peach considered it would be an absurd policy to allow a private company to come in and interfere with their monopoly. He thought, however, that the committee would do well to allow all the members of the Council to see the report and adjourn the question to the next meeting of the Council. Mr. C. H. Wright urged that it would be unfair to Mr. Bell to have his report made public at present, as it might be subject to great alterations hereafter. He did not think there would be any objection to a member of the Council seeing it privately. Alderman W. H. Peach, in replying to some of the criticisms which had been made, said that the area was fixed by the Local Government order, and it was that area to which the report referred, and to nothing else. With regard to the expenditure, the scheme was not fixed, and until the scheme was decided upon no tenders could be obtained. Referring to the cost of the gasworks, he said if their predecessors had taken up the manufacture of gas when it was first introduced to Stafford, they would have saved £50,000 of the ratepayers' money which was afterwards spent in the purchase of the gasworks. With regard to Leamington, he said in that town a totally wrong system was adopted, and the committee wished to avoid anything of that sort. They wanted to submit a perfect scheme, and he believed the course they were taking was the best which sensible business men could adopt. A division being taken, seven voted for the amendment and 14 against, and the report was then adopted.

PROVISIONAL PATENTS, 1893.

JUNE 5.

10860. **Improvements in or relating to arc lamps.** Wilfrid Swanwick Boult and Cedric Randal Boult, 323, High Holborn, London.

10887. **An improved system of town sewage disposal combined with production of electrical supply, and in means or apparatus therefor.** William Henry Hill-Hartland, 728, Grimesthorpe-road, Sheffield.

10888. **Telephone receiver and transmitter.** Andrew Erskine Muirhead, Cart Forge, Crossmyloof, Glasgow.

10937. **Improved electric meter.** Albert Harris Howard, 60, Broadhurst-gardens, South Hampstead, London.

10942. **Improvements in primary voltaic batteries.** William Walker, jun., and Frank Richard Wilkins, 7, Staple-inn, London.

10963. **Electro-mechanical switch and system of electrical intercommunication.** Emery Arthur Clark, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10976. **Improvements in apparatus for the electrolytical decomposition of brine and other liquids.** Malcolm Guthrie, 46, Lincoln's-inn-fields, London.

10987. **Improvements in the electric propulsion of boats.** Frank Robert Brown, 22, Southampton - buildings, Chancery-lane, London.

10993. **Improvements in electric search-light apparatus.** Gaston Sciama, 53, Chancery-lane, London.

JUNE 6.

11069. **Improvements in or relating to producing (or maintaining) continuous lines of telegraph wires, rails, pipes, and other metallic line structures, and in apparatus or devices connected therewith.** William Phillips Thompson, 6, Lord-street, Liverpool. (Elias Elkan Ries and Albert Henry Henderson, United States.) (Complete specification.)

11084. **Improvements in arc electric lamps.** Samuel Sealy Allin, 52, Woodstock-road, Bedford Park, London.

11092. **Improvements in electric batteries.** Marie Louise Mathilde Hellesen, *née* Barnekow, 4, South-street, Finsbury, London. (Complete specification.)

11,099. **Improvements in electric glow lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Allen Colby, United States.) (Complete specification.)

11105. **Improvements in electrolytic apparatus.** Thomas Craney, 45, Southampton-buildings, Chancery - lane, London. (Complete specification.)

11106. **Improvements in electrolytic cells.** Thomas Craney, 45, Southampton - buildings, Chancery - lane, London. (Complete specification.)

11107. **Improvements in electrolytic apparatus.** Thomas Craney, 45, Southampton - buildings, Chancery - lane, London. (Complete specification.)

11108. **Improvements relating to the electrolysis of salts and to apparatus therefor.** Thomas Craney, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11122. **Improvements in secondary batteries or accumulators.** Antoine Edouard Peyrusson, 53, Chancery-lane, London. (Date applied for under Patents Act, 1883, Sec. 103, April 1, 1893, being date of application in France.)

JUNE 7.

11143. **Improvements in electrical switches, fuses, ceiling plates, wall connectors, and the like.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

11168. **Improvements in arc lamps.** Ben Death, 27, Martin's-lane, Cannon-street, London.

11176. **Improvements in electrical indicators.** John Thomas Gent, Alwyn Walter Staveley, and Isaac Hardy Parsons, 4, South-street, Finsbury, London.

11177. **Improvements in fittings for electric glow lamps and in the means of producing the same for decorative and advertising purposes.** Paul Ward and Edward Cooper, 8, Exhibition-road, South Kensington, London.

11184. **Improvements in apparatus for effecting electrical communication between a number of separate stations or apartments with a central station or apartment.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (F. E. Morgan and H. E. Walter, United States.)

JUNE 8.

11235. **An improvement in electric motor fans.** Joseph Arthur Wade, 23, Huntley-road, Fairfield, near Liverpool.

11294. **Improvements in automatic electric exchange.** Robert Pippette, 31, Endymion-road, Brixton-hill, London.

11299. **An improved electromagnetic machine or motor.** Moriz Reichsritter von Léon, 45, Southampton-buildings, Chancery-lane, London.

JUNE 9.

11384. **Improved method of and apparatus for regulating the electromotive force of electrical generators.** John Smith Kaworth, 46, Lincoln's-inn-fields, London.

11387. **Improvements in microphones.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

JUNE 10.

11391. **Improvements in electric motors and dynamo-electric machines.** Robert Shepherd, 85, Coldharbour-lane, Camberwell, London.

11426. **Electric motor.** Herbert Luzerne Todd and George Lewis, 46, Fish-street-hill, London.

11427. **Improvements in and connected with electric accumulators or secondary batteries.** John Charles Howell, Rookes Evelyn Bell Crompton, Carl Frederick Claus, jun., and the Crompton-Howell Electric Storage Company, Limited, 55, Chancery-lane, London.

11439. **An improved machine for giving electric shocks automatically by the insertion of a coin.** George Bryant, 51, Cricketfield-road, Hackney Downs, London.

11446. **An improved electrical foot-warmer.** William Eugene Ulmer, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1883.

3116. **Telephonic communication.** Pitt. (Scribner.) (Second edition.)

1890.

19486. **Telephonic switching apparatus.** Bennett. (Second edition.)

1891.

2664. **Cutting coal by electricity.** Atkinson. (Second edition.)

1892.

10608 **Electrical accumulators.** Drake and others.

10855. **Secondary batteries.** Kirkpatrick-Picard and another.

11050. **Tubular electric conductors.** Cook and Payne.

11823. **Measuring electric currents.** Aron.

13072. **Coupling and fixing glass tubes for electric wires.** Rylands and Slater.

13095. **Electric heating of pottery, etc., furnaces.** Von Poschinger.

13146. **Microphones.** Forbes.

13338. **Switchboard.** Forbes.

15057. **Electric arc lamps.** Brockie.

15120. **Electrical accumulators.** Headland.

15194. **Telephone transmitter.** Mayer and Jameson.

18160. **Telephonic receivers.** Annett.

1893.

3285. **Electric railway signals.** Clarke.

3675. **Telephone transmitters.** Mayer.

5911. **Electric contact maker.** Mann.

7758. **Electric fire alarm.** Kloss.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¾
— Pref.	—	2½
City of London	—	12½
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	6¼ 4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3½
Westminster Electric	—	5¾

NOTES.

Personal.—Prof. T. Hudson Beare, professor of engineering at University College, was formerly a graduate of the Adelaide University.

Society of Arts.—The conversazione of the Society of Arts will be held on June 30 at the Imperial Institute, not on the 21st, as at first fixed.

Surgical Lamps.—A testing experiment is to place an over-run surgical lamp inside a patient's mouth and turn out the other lights, when every vein, line, and imperfection is clearly seen.

Electric Crane.—The *Revue Industrielle* (June 27) contains a double-page set of drawings of a 15-ton electric travelling crane, made by MM. Broadbent. A 10-h.p. motor is used to drive all the various mechanism. Working details of the parts are given.

Australian Smoking Concert.—The third of the very enjoyable smoking concerts directed by the Electrical Club of New South Wales was held on the 5th ult. About 250 gentlemen assembled; all the professions—academic, legal, engineering, military, naval, architectural—were represented.

Limited Liability.—The Swiss Commune of Martigny-Bourg, in its official capacity, together with some 40 of the inhabitants, have, by Act of Parliament, formed a limited company, under the title of "Commune de Martigny-Bourg et Cie.," to light the town with electricity by means of water power.

Dangers of Cable Cars.—The grip of a cable car became entangled in a loose knot of unravelled cable on a Chicago cable line recently; the car could not be detached, and travelled on until a collision split off the grip, which in its turn still continued its way and tore the floors of many other cars before the cable was stopped.

Training of Electrical Engineers.—In Mr. Joel's letter last week on this subject, in the second paragraph the second sentence should read: "For the first year or two we took them without premiums." As given, with full stop after the first phrase, it would read as if the firm trained lads for a year or two without premiums, which is not now the case.

Physical Society.—To-day (Friday, 23rd) papers will be read before the Physical Society, South Kensington, at 5 p.m., by Mr. Nalder on "Exhibition of a Form of Carey-Foster Bridge"; Mr. Pidgeon on "An Influence Machine"; and Mr. Wimshurst on "An Influence Machine." The latter paper will be illustrated, we understand, by the latest form of Mr. Wimshurst's machine.

City of London Company.—A healthy state of finance seems to be shown by the last issue of preference shares in the City of London Company at £2 premium. The Company is doing a very large amount of work, of which as yet not much attention has been paid in either the technical or daily papers, as from the extent of the work it cannot soon be finished.

Electric Hauling.—At the Rock Springs coal-mine, Rock Springs, Wyoming, an electric locomotive has been introduced to haul a number of trucks a distance of 6,000ft. The current is supplied by a dynamo located a mile distant from the mouth of the mine, the generating pressure being 550 volts. The loss in transmission from the power-house to the mine is about 10 per cent.

Chicago Jury.—Prof. Ayrton has left for America. Mr. Conrad Cooke is already out there as one of the jurors. The date fixed for meeting was at first June 1, but at the last moment a telegram came putting it off till July 1, not before Mr. Conrad Cooke had taken his passage and could not alter his arrangements. An extra month is pleasant, but may have inconveniences for a busy man.

Lyons.—An installation has been erected at Lyons by MM. Alioth, of Basle. The distribution is overhead on insulators attached to the houses. The dynamo gives 250 amperes at 170 volts, and a battery of Tudor accumulators, discharging at 120 amperes, is also used. The price is 9½d. a unit. About 500 lamps are supplied, and more are being added. A determined effort will be made to oust the gas in the best districts.

Technical Catalogue.—For technical authors and others requiring knowledge of books on the subjects published on the Continent, the "Catalogue de la Bibliothèque" of the Société des Ingénieurs Civils for 1893 will be useful. It contains lists of books, more particularly in French and Italian, on subjects such as railways, chemistry, machine construction, lighting, mines, mathematics, electricity, technical education, transport, and so forth. Great care has been taken in the arrangement of the matter.

Electrical Lead Poisoning.—The *Lancet* remarks upon the recent tests in telephoning along gas-pipes: "The small though distinct currents that are set up when the gas and water pipes are connected are attributed to a slow chemical change in the pipes, which may thus represent the plates of a battery. This hypothesis leads one to think of the probable nature of these changes and to wonder whether any effect is produced in the water contained in the water-pipes, or whether perchance minute traces of metal as a result of the change would find their way in solution into the water. If the latter event took place another and hitherto unsuspected source of lead poisoning might possibly be traced."

Ships' Electrical Fittings.—The *Transactions* of the N.E. Coast Institution of Engineers and Shipbuilders just issued (Andrew Reid and Co., London and Newcastle) contains the careful paper by Mr. L. Newitt on "Ships' Electrical Fittings for Lighting, Signalling, Telegraphing, and for Motive Power." The paper is illustrated by a number of large drawings of actual appliances—fuse, electric cooking stove, flashing lamp, searchlight, night-sights for guns, signalling apparatus, diagram of telegraph arrangements on a battle-ship, electric winch, combined engine and dynamo, steam turbine and dynamo. This most practical paper, which we have already given, is very creditable to the author and the institution.

Alternate-Current Motors.—The Allgemeine Company have sent a set of alternate-current motors to Chicago, ranging from ⅛ h.p. to 50 h.p. The current of the latter at starting does not exceed 40 per cent. of that at full load. The efficiency at full load is 90 to 93 per cent., the current being 280 amperes at 100 volts, and the speed 725 revolutions. The following are the figures of the various sizes:

H.P.	Watts absorbed.	Current.	Weight (lbs.).	Efficiency.
⅛	230	1·4	40	—
½	518	4	140	0·71
1	985	8	205	0·75
5	4,380	36	560	0·84
50	40,200	280	2,640	0·91

The first type is two-pole, the three next four-pole, and the 50 h.p. motor is eight-pole.

Manchester Telephones.—The list of names of the New Telephone Company, Manchester, just issued, contains over 500 names, arranged conveniently for reference in long slip form. Three call-boxes, on the boards of the Royal Exchange, are now open, and all subscribers who are also members of the Royal Exchange are entitled to use the boxes within a radius of six miles free of charge. Exchanges are now open at Bolton and Radcliffe, Eccles and Pendleton, and trunk-line communication on the metallic-circuit system is provided with Manchester. The exchanges are open day and night and on Sundays. Mr. George J. Somerville, A.I.E.E. (late of the New Telephone Company, London), is the district manager. The company would seem to be in flourishing condition.

Artistic Lighting.—A short treatise on "Electric Light and Power" is published (price 1s.) by the Electrical Installation Company, of 64, Victoria-street, Westminster. "Knowing how miserably many firms have failed in supplying [? satisfying] the artistic feelings of the cultured classes in the matter of light," the company have devoted themselves to a study of all that is best in the metal designing of the past centuries—with very creditable results if we may judge from the pamphlet. Wrought-iron delicate brackets with crinkled shade, antique copper candelabra, and Japanese figures holding flame lamps are given in illustration. The Florentine hanging lamp is "just too lovely," and the Louis XV., Venetian, and other artistic styles suit well the positions they are made for in high-class houses. Yacht-lighting, town and country house lighting is alluded to, and electric lifts are not left without mention. The pamphlet is printed in brown ink on cream paper, and is very artistically arranged.

Influence of the Electric Railway.—Official corroboration was given on Tuesday, before the committee of which Lord Cross is chairman, to rumours long prevalent as to serious electrical disturbances caused by the working of electric lighting and electric railways and tramways. In evidence before the joint committee of the Lords and Commons, Sir Courtenay Boyle, permanent secretary of the Board of Trade, showed that the effects of the working of the electric lighting of Preston were to be found on the gas-pipes embedded in the earth. The conductors of the return current were not continuous, and in arcing or jumping from one conductor to another the current damaged the pipes to such an extent that a serious accident might have been the result. Mr. Preece, chief electrician of the Post Office, stated that the working of the City and South London Electric Railway was felt electrically in the observatory at Greenwich, and at North Walsham, in Norfolk, which was connected with London by wire. When the railway ceased working at night the effects ceased at both those places, and at the Post Office here.

Active Material of Accumulators.—W. A. Boese (says a note in *Revue Industrielle*) has invented a process of preparation of active material for accumulators of some interest: It consists in mixing metallic oxides, such as oxide of lead, with sulpho-combined acids of anthracene and other organic compounds, and forming the mixture into plates. In practice, the metallic oxides are mixed with the residue of coal tar, transformed into sulphur combinations by extracting the petroleum ether, adding sulphuric acid, distilling the solvent and provoking the formation of the desired compounds. For the extraction of the residues of distillation, alcohol may be employed as solvent instead of petroleum ether, so that by mixing the product with the sulphuric acid and a metallic oxide (oxide of lead), the heat given off by the action of the acid on the alcohol is sufficient to provoke the chemical action on the hydrocarbons at high molecular weights contained in the alcoholic extract, without recourse to external heat. According to the inventor, the plates obtained by this process acquired great stability in consequence of the gglutinative properties of the salts when mixed with *thracene*-sulphonic acids or their analogues.

Government Telephones.—The "vulgarisation" (as the French would say) of the telephone proceeds apace; and it is to be hoped that England's telephonic system will soon be abreast or ahead of that of any other nation. Government is active in this direction, and considerable developments may be shortly expected. In [illegible] *Pall Mall Gazette* interview, which we reproduce elsewhere, Mr. W. H. Preece, F.R.S., chief engineer of the Post Office, predicts that the telephone is destined largely to take the place of the telegraph; and the telegraph is to be greatly developed, especially for Press work. "We propose," said he, "to establish at Leeds, in the very centre of England, a telephone exchange, with which every chief town in the United Kingdom will be connected, so that it will be possible for any town to speak with any other. A man sitting at his desk in the city of London will be able to speak with his correspondent in Glasgow or Aberdeen. A shipbuilder at Belfast will be able to speak to his client in Southampton, while the invalid at Torquay will be able to consult his doctor at Newcastle by speech. It is intended that the work in the towns themselves shall be done principally by the telephone companies, but the Post Office itself will open exchanges where there are no companies."

Cost of Electric Cooking.—Mr. Thos. Fletcher, writing to the *Journal of Gas Lighting*, says he is greatly in favour of cooking by electricity, as there can be little doubt that it is simply an introduction to gaseous fuel. Those who employ electricity for cooking will be charmed by the cleanliness and ease with which it can be done on a very small scale. But when they wish to enlarge their operations, the enormous cost of electricity for heat, under the best possible conditions, will bar the way; and its users being accustomed to cleanliness and ease, it is only natural that gas will be finally adopted Having been connected with the manufacture of electrical cooking apparatus almost from the first attempts made, he claims to have some little knowledge of its capabilities; and sees no reason why its use should not be encouraged in a fair and open way, so long as its enormous cost is known and acknowledged. Once get consumers accustomed to cleanliness and neatness in cooking, and the way is open at once for gas, which will do the same work as electricity, and do it as least as well, at one-twentieth of the cost, or probably even less. His conclusion is, the extended use of electricity for cooking on a small scale will lead to an enormous increase of gas cooking on a large scale.

International Industry.—Our note on April 14 on "Foreign Patents Worked in France" has cause a little stir between the French and German journals. The note was taken from *L'Electricien*, and referred to the working of German patents (Zipernowski, Dobrowolski, and Siemens) by the best French firms. This caused "profound sorrow" to M. Haubtmann, the writer of the article in question. From "daily anxiety" in our note, this became "national pride deeply touched" in the *Elektrotechnische Zeitschrift*, and *L'Industrie Electrique* took up the gauntlet. The editor of the German paper courteously writes to *L'Industrie Electrique* pointing out that the article was not written in Germany, but on the banks of the Seine, and that he had always held French inventions in honour. The truth is (as M. Hospitalier adds) science is of no country, though the commercial interests are. Englishmen do not feel their pride profoundly touched because of our well-known electrical engineers, two—Reckenzaun and Kapp—are Austrian; nor is America less proud of Tesla that he is a Montenegrin. Practical science must "prendre son bien où elle le trouve"; and while England uses the work of Edison, Thomson, Brush, Tesla;

Brown, Schuckert, Dobrowolski, Siemens; Planté, Faure, Gramme, so France and other countries use those of Swan, Hopkinson, and Hughes—nor is "national pride touched" in so doing.

Tesla Patents.—The phase of litigation seems to have set in over the Tesla multiphase-current patents. According to the *Electrical World*, two suits have been entered by the Westinghouse Company against the Thomson-Houston Electric Company, a corporation of Connecticut, and a member of the General Electric Company, for infringement of a number of patents granted to Nikola Tesla, and to restrain the operation of a plant near Hartford involving the multiphase distribution of electricity covered by Mr. Tesla's patents, which are now owned by the Westinghouse Company. It is claimed for the Tesla patents that they broadly cover all systems for the distribution of multiphase currents of electricity for power purposes, and the fact that the Thomson-Houston and General Electric Companies are in their operations making copies of the Westinghouse Company's apparatus, together with the fact that these patents have heretofore been fully respected and acquiesced in by all parties, strengthens the position of the Westinghouse Company. Efforts will be made by the Westinghouse Company to have these suits brought to a final hearing during the present year. A successful termination of these suits will mean, it is claimed, that the only practical method of transmitting power over long distances by means of multiphase alternating currents of electricity will be entirely controlled by the Westinghouse Company, a branch of the electrical business that will in the near future probably require more electrical apparatus than any other.

Mesnard Photometer.—The principle of the new photometer invented by M. Eugène Mesnard is very simple. If the end of a hollow stick of glass is exposed to light, and the other end is examined in a dark-chamber, a luminous circle of light is seen, more or less brilliant according to the strength of the light. The light is conducted along the body of the glass, and this notwithstanding that the glass rod may be bent. The intensity of the luminous image may be easily measured by superposing absorbing screens of known value, until all light is extinguished. In practice the instrument receives the following form: the glass rod, at one end of which light is received, is covered by a tube of opaque indiarubber, and fixed by its other end in a cork which closes a metallic tube about half metre long and 3cm. diameter (20in. by 1⅛in.). This tube acts as dark-chamber. The eye placed at the other end of the chamber distinguishes clearly a luminous circle, whose strength is then to be examined. This is done by allowing a certain quantity of tinted liquid to run slowly out of a vessel at the side through a tube into the lower part of the dark-chamber until all light disappears. A constant multiplied by the height of the liquid, as seen in a transparent test tube alongside, gives the candle-power. Various strengths of liquid can be used according to the light to be examined. By the aid of a standard a curve of values can easily be constructed for each of these liquids. The whole arrangement makes a portable and easily-used photometer.

Electric Cooking and Heating.—Reports compiled by Mr. Carl McFadden from electric roads in North America and Canada, where the winters are extremely cold, show that 1,200 to 1,500 watts is sufficient current to keep a 16ft. car warm in all sorts of weather. Coal-stoves cost 10d. to 20d. per day, taking into account labour and firing. If it be assumed that the extra cost of coal at the power-house is the only cost of running electric heaters, it is not only a cleanlier but a cheaper means of warming cars. A net horse-power at an engine of 500 h.p. is about ·3d. per hour; the cost of an electrical horse-power is at this rate ½d. per hour. From these data it would seem that each car heated costs just about 10d. per hour. There is no attention required, no space is taken up, no ashes or cinders to spoil upholstery. Where power is obtainable at 50s. a horse-power (as it is in the West with Pelton wheels) or even 30s. to 40s., it is possible that electric heating might be economically used. We require more data, however, on the cost of current for electric heating and cooking. Perhaps those now in the position to give figures will send a detailed list of the watts required and cost per hour or per operation. The figures yet obtainable are scanty, and there is no reason why we should not know exactly what electric heating does cost, even if at present it greatly exceeds the cost of ordinary fuel. All that we are sure of as yet are a few odd details, such as those given above. "A small tea-kettle," we learn, takes 250 watts, and furnishes boiling water "in a few minutes." This is vague. There is or might be one advantage about electric cooking which we think has not yet been sufficiently insisted upon—that a few experiments determining the current and time required for various dishes, cooking becomes reduced to an exact science. We shall have formula for mutton chops and steaks, such as "½lb. loin chop = 250 watts × 18·5 minutes," or "¾lb. steak = 475 watts × 16 minutes." For boiling water, eggs, and such like determined actions, we might even have sand-glass switches. There is money in the idea. A cook's handbook should also be issued in the above style: title, "The Science of Electric Cooking." We will promise to give both switch and book a notice when issued.

Automatic Transformer Cut-out.—The struggle for existence between systems is becoming very close, and constant endeavours by the advocates of each lead to better and better results in the race for cheap electricity. In brief, five systems hold sway—continuous current direct, continuous with accumulators, alternating with separate transformers, alternating with transformer sub-stations; lastly, the system, having much to recommend it under many circumstances, which is to be used at Budapest—alternate-current transmission and direct current distribution with batteries. The whole question of system centres round the relation of cost of generation to actual sales. The simple arrangement of alternator and house transformer, once thought ideal, has been brought up strongly in the race, because of the astounding waste of magnetising current over the whole 24 hours; and sub-stations have taken the field in the largest enterprise in England—the City of London lighting. Ill days seemed ahead of the house transformer systems unless some saving could be made in the loss of magnetising current. The new apparatus of Messrs. New and Mayne, which we described the other week—an automatic switch for transformers—steps in apparently to reduce the opponents more nearly to a level once more. We shall be greatly interested to see how this apparatus is found to work out in practice, and what is the saving it actually effects. The price of installation—some £10 or so each at present—is to be taken into account; perhaps this will be less in future. The automatic switch cuts the transformer in and out at the turning on of the first light and off of the last one. By an ingenious system of solenoids and levers that seem to act with surety, a relay (actuated either by a dry cell or a condenser on the mains) trips up the switches of both primary and secondary. The magnetising current is therefore on only during the time of actual lighting. There are two ways, of course, of reckoning the saving—at cost price and at selling price—for if saved the current at present expenditure of energy will be available for so much more revenue. At 7¼d., the present price on the London mains, the saving on the average house transformer is calculated by the inventors as amounting to £4 each per annum. This is a noteworthy saving, and would soon pay for cost of apparatus. The automatic transformer switches can be seen in action at Woking, and it is probable that specimens will be fitted up shortly in London. The importance of the question can hardly be over-estimated in transformer practice, and we should like to have full particulars and discussion of the results of working.

A New Electric Welding Process.—At a meeting of the Society for the Promotion of Industry held in Berlin, Dr. A. Slaby, professor at the Technical High School, gave a practical demonstration of a new electrical method of welding and forging iron. In the demonstration an iron bar, forming the pole of a source of electricity, was placed in water containing the other pole. As soon as the iron bar touched the surface of the water the iron glowed as far as it was dipped into the fluid. Dr. Wedding, who supported the demonstrator, was able to forge the iron thus treated into a rivet. The new process, which is the invention of M. Julien, of Brussels, is carried out on the following basis: When the poles of a source of electricity are immersed in acidulated water or water which is made conductive by a solution of salt, and a sufficiently powerful current is passed through, oxygen is given off at the anode (a lead plate) and hydrogen at the cathode (an iron bar). On increasing the strength of the current, the development of gas can be so raised that the iron bar is completely encased by hydrogen, and is no longer in contact with the fluid. As, however, the hydrogen encasing offers a very strong resistance to the current, the electrical energy is converted into heat by which both the hydrogen encasing and the iron bars are made glowing hot. By this method it is said that temperatures up to 4,000deg. can be attained. According to Dr. Slaby, there is no difficulty in regulating the temperature for 800deg. to 1,200deg., as required for the forging or welding of the iron, as the degree of heat depends on the proportion of the size of the anode to that of the cathode, as well as on the available electric pressure. On these grounds there is claimed for the new invention a great advantage over the Benardos process. In this the light of the electric arc is used for heating the iron. As, however, it has hitherto not been possible to properly adjust the heat, the points of welding present an uneven appearance owing to the iron being partly burnt. The Benardos process is consequently only used in such cases where the joint can be subsequently touched up. As compared with the Thomson process, the new one is said to have the advantage that with a tension of 100 to 200 volts, iron bars of two to three centimetres diameter can be welded, while the Thomson process requires exceptionally powerful currents, which cause the process to be dear and dangerous. The new process can be carried out without any particular difficulties. Anyone having an electric light supply can make the experiment for himself. For the anode, as large a lead plate as possible is taken. The socket in which the iron bar is held forms the cathode.

The Telephone in Sweden.—The report from the British Consul at Stockholm deals with the rapid growth of the telephone in Sweden since 1891. The Government in that year undertook the task of extending communication throughout the principal towns. If it had not, the Stockholm Allmanna Company would have done so, to the detriment of the telegraph service. A keen competition has thus ensued. Beyond Stockholm the Government has the advantage, but in Stockholm the Allmanna is a rich and powerful company, and numbers 7,000 subscribers, while the State only has 1,600. The Allmanna Company has been compelled to double its wires, and adopt the twin-wire system. With a view of obtaining information at first hand as to the intentions of the Swedish Government with regard to the extension of the telephone system in the immediate future, the consul had recourse to Mr. Hultman, chief inspector of the State telephones in Stockholm. He informed him that the great work of extending the network of telephones between all the towns of any importance in the kingdom would, it was confidently anticipated, be completed within the next four or five years. By that time it would be possible to converse between Haparanda, at the extreme north, and Malmo, at the southern point of the peninsula. It is not expected that the great distance (933 miles) will cause the sound of the voice to be indistinct, except perhaps in very rough weather. Over aerial lines, in fine weather, he stated that the loss of distinctness from distance is not great. With cables, either submarine or subterranean, the case is different. Mr. Hultman's experience is not confined to Stockholm. He has visited the United States and made himself acquainted with the details of the American telephone systems. This circumstance gives considerable point and interest to some of the information with which he was kind enough to supply me with regard to the formidable works of construction upon which the Swedish Government is at present engaged. For instance, he stated that one of the greatest difficulties that has hitherto impeded the laying down of municipal telephones—namely, the question of overhead wires—has, in his opinion, been more successfully dealt with by the State Department in Stockholm than has previously been found possible. There are many objections to the extensive employment of overhead wires and cables. To their alternative, underground cables, the single objection of expense has hitherto often been found insuperable. In Stockholm, nevertheless, the Government has laid down underground cables which have cost no more than overhead cables—that is to say, 10 ore (1⅓d.) per metre per subscriber, which, again, is only about double the price of a single aerial lines. Mr. Hultman states that the underground cable systems which he inspected in America had cost at least four or five times as much. As to the cause of this great saving in expense, Mr. Hultman's explanations were somewhat technical, but it seems that the main point is that it had been found possible to dispense with the iron tubing which had hitherto been considered necessary for encasing the cables. The superiority of the Stockholm telephone system, according to Mr. Hultmann, mainly consisted in the excellence of the instruments and materials employed, and the high standard of workmanship exacted in every branch of construction. Mr. Hultman was very emphatic about the mistake that had often been made in other countries, and to a certain extent also in Sweden, in laying down, for the sake of cheapness, single grounded lines instead of double metallic circuit lines. Another point of superiority is the great care that is taken in Stockholm with regard to the efficiency of the staff of employés. For instance, an inspector every day goes round among the subscribers' instruments, provided with a stop-watch, and when he makes a call he notes the number of seconds that lapse before he receives an answer from the exchange station. Thus each employé at the exchange finds himself (or herself) confronted every morning with a slip of paper on which is written his record of the day before.

ALTERNATE-CURRENT TRANSFORMER DESIGN.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 599.)

The iron in this transformer provides the greater part of the cooling surface, and the laminations as placed act well as radiators. The total surface of iron exposed to the air is 1,358 square inches, and the ends of the copper coils, with insulation, provide about 132 square inches more. This gives a total cooling surface of 1,490 square inches. The watts wasted at no load are 168, and at full load the total loss is 288 watts. These figures give a mean of ·113 watt per square inch at no load, and ·193 watt per square inch at full load.

As might have been expected, from the large amount of material used, these figures are more than those obtained in the first design in spite of the increase in the iron loss. Besides this, the plates surrounding the coils are arranged so that the laminations all run out to the surface. Thus the heat can be readily dispersed by conduction. Still, in spite of this great advantage, which accounts in some measure for the low temperature rises found in the Westinghouse and Mordey transformers, it must be remembered that it is impossible to obtain the temperature of the wire in the centre of the transformer. The heat generated in wires at the centre will mostly pass out through the insulation to the iron and thence to the air. Hence the temperature of the wire in the middle must be considerably higher than that of the inside edges of the iron plates. The inside edges will again be hotter than the outside, but the difference will not be so much, as the iron is a good conductor compared with the insulation on and round the copper. So although the temperature on the outside is low, the copper wires in the middle may get too hot.

The great point to be noticed in the above results from this design is that the ratio of weight of copper to weight of iron is small (only ·144). This ratio is fixed for the type described by the mechanical arrangements of the core, but, as seen above, this method of construction has already been modified in order to get more iron in. The saving in the iron stamping effected by the use of every piece of iron stamped out will not make up for the want of efficiency in the transformer, and so for large sizes the proportions given above are not adhered to. By enlarging the windows we are enabled to wind more turns in both primary and secondary, and hence to reduce the flux required. Again, by this alteration less iron can be used, and hence the total weight and cost can both be reduced without prejudicing the efficiency. Still, the design worked out above would give good results if better iron were used.

Another point to be noticed is that the power factor is of the same order as that obtained in the first design, where the length of the iron circuit was 123 centimetres. The decrease in length of the path of the magnetic lines would give a corresponding decrease in the current required to magnetise the iron, i_μ if the number of turns in the primary were the same. In this case, however, the number of turns in the primary are much fewer than in the previous design, and hence the i_μ comes out about the same proportion of the total no-load current. The value of i_H is independent of the shape of the iron circuit, and depends only on the induction, frequency, and the total weight of iron used, provided the plates are so arranged that no secondary currents are induced in them other than the usual Foucault currents. In further development of this design, the two alterations most likely to effect improvements in the results are (*a*) the enlargement of the window, (*b*) the shortening of the whole transformer. How far the reduction of the length can be carried without increasing the core is a matter to be determined by careful trial.

The mechanical construction of the above transformer with the Mordey method of building the core is as follows. The two coils are wound on a former of the exact shape required by the windows left in the iron, and are then carefully insulated. The ends of the wires are usually all brought out at same end of the coils. The semi-circular spaces at each end of the coils are filled in with a block of wood or other non-conducting material, Fig. 13. The coils are then taken off the former. In building up the iron on the insulated coils, a hollow rectangular stamping is first threaded over them, and next the piece forming the core is placed through the coil, as shown in Fig. 12. These operations are repeated till the whole length has been built up. Bolts connected to flanges at either end are tightened occasionally, so that the plates are forced into as small a length as possible. When the full number of the stampings have been got in, their bolts are finally tightened, and thus prevent any displacement of the plates when the transformer is being moved afterwards.

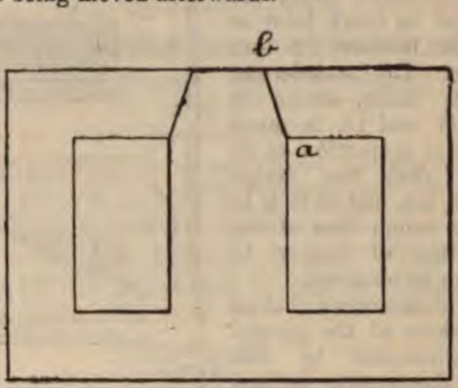


FIG. 15.

There are several other makers who use a type similar in general outline to the above, and the mechanical constructions adopted by two of them are worthy of special note. The Westinghouse transformer is shown in section in Figs. 15 and 16. As will be seen, the appearance of the section is very similar to that used in the transformer, Fig. 12, except that the windows take out a larger proportion of iron; also the length of this transformer, as compared to its other dimensions, is shorter. The splendid efficiency of a 6·5-kilowatt transformer of the Westinghouse type, as measured by Dr. J. Hopkinson and Dr. Fleming (see the list, page 479) makes this design of special interest. The material used in the core is said to be a special make of very soft steel plate. The core plates consist of single stampings, Fig. 15, of rectangular shape, with two windows punched out where the wire is to be placed. To enable these stampings to be threaded on to the coils, the plate is cut through in two places, from the window out to the long edge of this rectangle, as shown by the lines (*a*, *b*), Fig. 15. The cross yokes, thus separated from the core, can now be bent back, and the stamping placed in position on the coils. These cross-pieces are then straightened again, and the stamping is then flat, embracing the coils. Alternate plates are placed on from different sides, so that the joints (*a*, *b*) on one plate are covered by an unbroken part of the next. The rest of the construction is carried out as before, the wires being wound on formers, and well insulated from the iron by insulating cloth and other material able to withstand the mechanical abrasion while the core is being built up. When complete, the iron plates are clamped up by four bolts placed at either corner, as shown in Fig. 16. The good quality of the iron or steel plates used accounts in some measure for the splendid efficiency of this transformer, but the general proportions must also be very carefully designed.

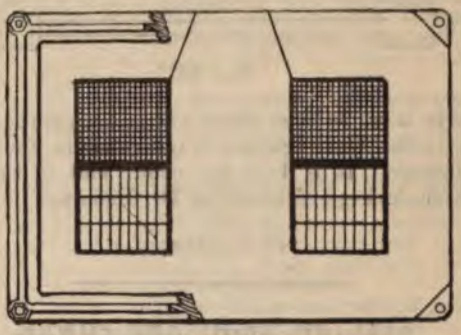


FIG. 16.

The other transformer referred to is the Elwell-Parker, and in this case the iron circuit round each of the windows is kept distinct. The coils are insulated in the usual manner, and each side of the long rectangle of copper wires thus formed are surrounded by plates of iron, Fig. 17. These plates are hollow rectangles, stamped out whole, and then cut through at one place, much in the same manner as in the Westinghouse plates. This enables one side to be bent back, in order that the stamping may be slipped on to the wire, then this side is straightened again. The successive plates are arranged to break joint as described in above for other designs. The transformer of this make, shown in Figs. 17 and 18, is much shorter in proportion to its length than the design worked out, and as it is to scale a rough idea of the proportion of copper to iron can be obtained.

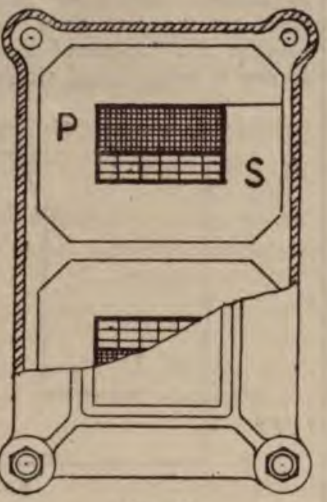


Fig. 17.

It will be noticed that all the makers of the general type illustrated by this second design seem inclined to keep the length of the transformer down. The object of this is that the mean length of the copper circuits to enclose a given area, or take a given total flux, is much lessened by this step. This reduction in the π of the copper saves weight and space, both of which are valuable. Still, some makers do not reduce the copper weight, but prefer instead to add more turns in the space, and thus reduce the iron loss. This seems an easy method of increasing the efficiency, but the magnetic leakage is also much increased, and needs further changes in the methods of winding.

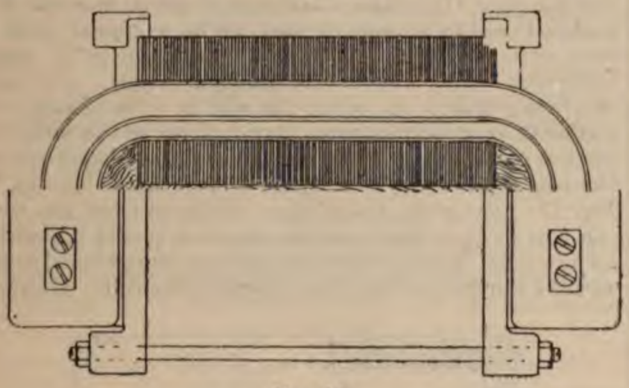


Fig. 18.

That this is so is seen from the fact that the magnetic leakage in the Westinghouse transformer in the list is its worst feature. It is 1·02 per cent., and is the highest percentage leakage recorded by Dr. Fleming.

(To be continued.)

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

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(Continued from page 553.)

ARC LIGHTING.

It was stated in a former article that we have every reason to believe that there can be no light without the presence of heat. Heat is a mode of motion and a source of energy, so is light, but the amount of heat energy that we are capable of converting into radiant light energy is only an extremely small fraction of the total. Study Nature's animate display of the conversion of energy into *light, a living* machine—the glowworm. Here, by some secret laws unknown to us, we have the most wonderful example, one that dwarfs our most ambitious productions into nothingness. The enormous loss incurred by producing electric energy from the heat energy given off by burning coal has already been mentioned. The very best machinery and apparatus will only yield us 10 per cent., and great is the problem to be solved that will enable us to produce electric energy direct from coal, instead of being compelled to employ those terribly wasteful converters—the boiler and steam engine.

But a far more important problem to tackle is how to convert electric or heat energy direct into radiant light energy without the enormous and almost, we may say, total loss our present methods give, for, whereas, in the first case, we can utilise one-tenth of the heat energy contained in the coal, in the second case, so far as we can judge, we do not obtain anything like this, but only a very minute portion of the whole.

After this digression we will return to practical matters. There are two chief ways of converting electrical energy into heat energy and then into light—first, by producing an "electric arc," second, by raising a refractory substance to incandescence, the first being known as the "arc lamp," and the second as the "incandescent lamp." In both cases carbon is used, which is raised to such a high temperature by the passage of the electric current through it, that it becomes white hot, and so emits lights. We will deal with the arc lamp first, and then with the incandescent.

The principle of the arc lamp was explained in the opening paragraph of these articles, and it is only necessary to add that the mechanism of all arc lamps, simple or complicated, is for the purpose of maintaining the two carbon rods at a definite and fixed distance apart, by feeding one or both forward, as they slowly consume away. In modern lamps the mechanism is controlled by magnets and solenoids, energised by the same current that flows through the lamp. Scores of arc lamps have been invented and put upon the market since the first display of the arc light, but very few of them were of any good, and well has the law of the "survival of the fittest" been exemplified. The domain of arc lighting is perfectly distinct from that of incandescent lighting, the arc lamp being essentially one for outdoor illumination, where for large areas it stands without a rival, in particular such places as railway sidings, goods yards, streets, smelting and foundry works, canals, docks, quay sides, bridges, naval and military purposes, etc.

It is now well understood that the light emitted by the arc lamp is almost entirely derived from the incandescent and glowing surface of the crater formed at the bottom of the positive or upper carbon. This "crater," as it is called, is a hollowing out of the carbon rod, and is somewhat conical in shape when it is well formed, and it seems to be the locality where the work is done, where the heat energy due to the electric current is dissipated and converted partly into radiant light energy. The work done consists of raising the carbon end to such a degree of temperature that it volatilises; the carbon vapour so produced streams across the air gap between the positive and negative carbon rods, and settles upon the tip of the latter carbon. The glowing state of the tip of this lower or negative carbon is believed to be due probably to the settling of the white-hot carbon vapour, and also to its proximity to the intense heat of the crater above. Certainly a small amount of light is emitted from the tip of the negative carbon, and also from the flame of the arc that plays between the two carbon ends.

Illuminating Power.—There are two common sizes of arc lamps, called by the trade a 2,000 nominal candle-power arc, and a 1,200 nominal candle-power arc. It must not be imagined that the first gives 2,000 c.p. and the second 1,200 c.p.—far from it; very often the candle-power is anything but the nominal. Besides these two sizes, arc lamps are made in a number of other sizes, one or two being smaller, a sort of miniature arc lamp, while the sizes above go up to very great candle-power; these, however, are used as searchlights, or projectors, as they are sometimes called. The remarks following will be confined solely to the two above-named sizes. The 2,000 nominal candle-power arc lamp, named a "full arc," takes usually about 10 amperes in current, at a pressure of 50 volts—that is to say, 500 watts, or half a unit. So that for every three-quarters of a brake horsepower given off by an engine one "full" lamp could be driven. The maximum actual candle-power yielded by this sized lamp is difficult to name; in fact, nobody seems to know exactly, photometric tests applied to the arc light being very elastic. Between 800 c.p. and 1,000 c.p. is considered to be near the mark, while the average candle-power, or the average taken for all angles of observation below the lamp, is probably not much more than 500. The 1,200 nominal candle-power arc lamp, named a "half arc," takes from six to seven amperes in current, at a pressure of 50 volts, or, say, 330 watts, or one-third of a unit, so that for every half brake horse-power given off the engine one "half" arc could be driven. The maximum actual candle-power may be taken somewhere about 500 to 600, and the average candle-power does not seem to be much above 300.

When arc lamps are used for indoor illumination they should only be fixed in large and lofty structures, so that the powerful light can be dispersed over a floor area unbroken by any obstructive features, such as partitions, stands, etc. It is a common practice, particularly in London, to cram half-a-dozen or so arc lamps into a small shop. The effect is brilliant certainly, but rather startling; probably the blaze of light produced acts on customers as the candle on the proverbial moth. Sufficient light is one thing, but an unbearable glare is something altogether different; these displays, however, have one redeeming character, they serve to light up the streets close by very effectively. The following tabulation gives an idea of the illuminating powers of arcs at different heights, four degrees of intensity being given; the arc in all cases being naked—*i.e.*, having no globe over it:

TABULATION 20.

Intensity of light.	Half arcs.			Full arcs.		
	Height in feet.	Radius in feet.	Area in square feet.	Height in feet.	Radius in feet.	Area in square feet.
A	30	114	80,000	40	170	100,000
B	30	68	16,000	40	76	20,000
C	15	24	2,000	15	34	4,000
D	15	17	1,000	15	24	2,000

The first row, A, denotes an illumination just sufficient to see the way about, and only gives light enough to work by, when close by the lamp. This degree would serve for lighting up a railway track, canal banks, etc., where the lamps are fixed a good distance apart; it is too expensive to light up well miles of track, so that the above suffices for its object. The second row, B, denotes a degree of illumination so that ordinary work can be carried on, and is applicable to railway sidings, sheds, docks, quaysides, foundries, streets, etc. The third row, C, is a good strong light suitable for all ordinary indoor lighting, whether railway stations, halls, mills, shope, etc. The fourth row, D, denotes a stronger light, for places where an extra good light is wanted.

The intensity of the light given off from the arc depends upon the point of observation. Imagine a circle described vertically round an arc lamp, having the arc as a centre; then the light given off depends upon the angle that the point of observation makes with the vertical line drawn through the lamp or centre of the circle. At an angle of 90deg. or at right angles—that is, looking at the lamp in a horizontal line with the arc—the light is about a quarter of the maximum. Above the horizontal line the light gets feebler very rapidly, because the crater then becomes hidden from view. At a vertical point above the arc there is no light whatever. Taking a downward course, we find that the light gradually increases in intensity, and when the angle is 60deg. from the vertical or 30deg. below the horizontal line the increase becomes very marked, the intensity being about three-quarters of the maximum; continuing lower down, when 45deg. is reached, or midway between the horizontal and vertical lines, the maximum intensity is yielded. Roughly speaking, the best part of the light lies between 30deg. and 60deg. below the horizontal, thus making 30deg. of light described as a belt round the arc; the light rapidly losing its intensity, whether passing beyond or within this belt. Beyond 60deg. below the horizontal the bottom carbon intercepts more and more of the light rays at 90deg. below the horizontal, or directly underneath the arc, there is no light—just as there was no light directly over the arc.

(To be continued.)

ELECTRICAL COMMUNICATION BETWEEN LIGHT VESSELS, ROCK STATIONS, AND THE MAINLAND.*

BY JOHN ROCHFORD.

The subject of electrical communication between outlying stations and the shore has lately attracted much attention. Shipping companies, chambers of commerce, and lifeboat institutions are particularly interested. The first-named on account of the anxiety which very often prevails as to the safety of their vessels and passengers, the second on account of the effect of the arrival of large cargoes on the market, and the last on account of their desire to prevent the loss of life, which, unfortunately, too frequently occurs.

LIGHT VESSELS.

Light vessels as a rule are moored with 200 fathoms of 1½in. or 1¾in. long-link chain, according to size of vessel, station, and depth of water. The old type of vessel measures 90ft. in length, 21ft. 6in. in breadth, 10ft. in depth, and 189 tons, builder's measurement. The latter type measures 103ft. in length, 24ft. 2in. in breadth, 12ft. 2in. in depth, and 272 tons, builder's measurement, and costs about £32 per ton. The difficulty in connecting a cable to a light vessel is caused by the continuous rolling motion and liability of the cable to foul with the moorings. The vessels as a rule are moored by a single length of chain attached to a 50cwt. mushroom anchor, but as the vessel swings with the tide and wind this arrangement does not suit very well as the continuous dragging of the cable on the bottom would soon fracture it. To obviate this to a certain extent bridles have been used.

In 1870 a strong vessel was moored 50 miles off Land's End in 60 fathoms of water and the electric cable attached to the masthead, but every time the vessel rolled the cable beat so heavily against the ship's side that it was injured considerably. After two months' trial the experiment was given up, as the communication was unsatisfactory. The cost of this trial was £15,000. In 1884 a vessel was moored by a bridle having a "Bidwell swivel" attached. This at first was not a success, owing to the cable chafing at the edge of the "Bidwell swivel," but after the edge was rounded and the hole made larger it worked more satisfactorily. This cable was specified:

Core.—The conductor to be a strand of seven copper wires, weighing 130lb. per nautical mile. Resistance at 75deg. F. shall not be more than 10 ohms. The conductor is to be insulated with three coatings of guttapercha of improved induction capacity, and prepared according to Mr. Smith's system, alternating with three coatings of Chatterton's compound, and to weigh 130lb. per knot, or within 5 per cent. thereof. The resistance of the completed core not to be less than 150 megohms per nautical mile, when tested at a temperature of 75deg. F. after 24 hours' immersion in water 14 days after manufacture. The core to be covered with a serving of jute yarn steeped in cutsh, or other preservative mixture, and applied wet.

Outer Covering, Shore End.—The service core to be covered with 10 galvanised B.B. iron wires, each wire to gauge No. 00 B.W.G., equal to ·375 of an inch when galvanised, or within 2½ per cent. thereof.

Main Cable.—The service core to be covered with 10 galvanised B.B. iron wires, each wire to gauge No. 1 B.W.G., equal to ·300 of an inch when galvanised, or within 2½ per cent. thereof.

Veering Cable.—The service core to be covered with 15 strands composed of seven galvanised iron wires, each wire to gauge No. 22 B.W.G., or within 2½ per cent. thereof.

Land Cable.—The service core to be covered with 12 galvanised iron wires, each wire to gauge No. 9 B.W.G., equal to ·148 of an inch when galvanised, or within 2½ per cent. thereof.

Outside Serving.—The cable manufactured as above to be covered with two of Johnson and Phillips's patent tapes laid on spirally in opposite directions, and three coatings of Clarke's composition.

Electrical Tests.—The standard of insulation for the completed cable with either current, before being submerged, to be not less than 250 megohms per nautical mile when reduced to a temperature of 75deg. F. after five minutes' electrification. The tests to be taken at the actual natural temperatures, and to be reduced by calculation to standard specified. The electrical of the cable when laid shall be such as having regard to its previous condition, and making due allowance for the mean actual temperature of the water, as shown by the resistance of the conductors, to give good grounds for believing that any fault exists in the insulator or conductor.

Lengths of Cable.—Shore end, one nautical mile; main cable, sufficient to connect ships with shore, 7·807 nautical miles; veering cable, 200 fathoms.

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* Paper read before the Institution of Civil Engineers, Ireland,

The instruments used were Wheatstone's, A B C, Morse, and Gower-Bell telephone. The telephone gave entire satisfaction. Daily tests were made on shore, and the following values obtained: The resistance of the guttapercha insulator was 1,519 megohms in the winter, and 172 megohms in the summer. The resistance of the copper conductor was ·77 ohm in the winter, and ·81 in the summer. The induction capacity was about 3·2 microfarads. The temperature of the water at the bottom of the sea was found to be 44deg. F. in winter, and 62·5deg. F. in summer.

The moorings were first formed by one arm of the bridle being composed of 130 fathoms of steel-wire cable, tested to 80 tons, and made of 14 strands of galvanised steel wire, No. 4 B.W.G., laid up outside a length of the main telegraph cable, the extremities being secured by Lucas's patent swivel. The steel wire cable was attached to 45 fathoms of 1½in. chain and a 50cwt. mushroom anchor. The veering chain was 100 fathoms long. This arrangement did not work well, owing to the steel-wire rope untwisting and retwisting, stretching, contracting, and forming into kinks, thereby breaking the conductor. New moorings were put down, having each arm composed of long-link chain attached to a mushroom, and fitted with a Bidwell swivel at the apex of the bridle; this answered very well. The electric cable was brought in over the bows and coiled on a drum, to allow of it being veered away when required. A method for preventing the twisting or untwisting of the cable has been tried. It consists of a buoy moored some distance from the vessel, and the main cable brought up through an aperture in the centre of the buoy. A light cable connects the vessel to the cable at the buoy. This light cable is wound round a travelling drum that works on the rail of the lightship. The cost of above experiment, which extended over two years, was £4,855. (This does not include the maintenance of the vessel, which was on her station as a lightship.)

A great improvement was made by Mr. Willoughby Smith, chief electrician to the contractors—the Telegraph Construction and Maintenance Company, Limited. It consisted of spirally winding a wire round a central wire. This was found to work better than having all the wires straight; for in the event of the central wire breaking, the coiled wire kept the contact good. This arrangement was only used for the veering cable.

A novel description of telegraph vessel was patented by the late Captain Moody. It consists of four rays. A model, 12ft. diameter from ray to ray, was severely tried at Southend. A sailing yacht on same principle with a shifting keel was also tried and done very well, sailing from Liverpool to Starre. The size of vessel suggested by the inventor for lightships and telegraph stations is: Length of beam, 80ft.; depth, 14ft.; hold, 5ft., divided into 13 water-tight compartments; height of tower for exhibiting light, 60ft.; central cabin, 30ft. diameter by 9ft. high; storerooms in rays, 20ft. by 15ft.; draught of water, 2ft. 6in. This design has been very well spoken of.

Outlying and Rock Stations.

The electric connections between rock stations and the mainland have been very successful in some cases, notably Lundy Island, in the Bristol Channel, and Tory Island, North-West Coast of Ireland. Samples of cables used in each place are exhibited. It will be noticed that the conductors of the Tory Island cable are protected by brass tape to guard against attacks by teredos. This last cable was constructed and laid by the India-rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown, London, under the supervision of their engineer-in-chief of submarine department, Mr. M. H. Gray. The connection by means of non-continuous cable is being experimented upon at present at the Needles, but so far is not quite satisfactory. The ends of the cables are 40 yards apart, and before commencing signalling by means of the cables, attention has to be drawn by means of visual signals. It is hoped all difficulties will soon be surmounted, as Mr. T. A. Edison is stated to have made electrical communication between passing vessels, by means of allowing an electric cable to tow astern of each ship (in the same manner as a log line). The length of each cable forms the radius of an electric circle, and when the electric circles thus formed coincide telephonic communication was established. After the labour and expense incurred, it is satisfactory to know that it has been recommended (some of the work is already completed) to connect 19 shore lighthouses at an estimated cost of £2,115; one pile lighthouse, estimated cost, £1,535; five light vessels, estimated cost, £11,455; three rock stations, estimated cost, £6,189; and one rock station by non-continuous cable by telephone (combined with Morse sounder) or by mirror galvanometer, estimated cost, £3,800, making a total of nearly £20,000—showing that perseverance has overcome many of the apparent impossibilities when some of the first experiments were made.

Recording Speed Indicator.—A printing speed indicator for dynamos and engine shafts, used in the Cornell University, is described by Mr. Geo. S. Moler. It consists essentially of a speed counter, which prints the number of revolutions at the end of each minute. It is connected to the shaft by sprocket wheels and chains; the type wheel is 8½in. diameter with printer's type clamped between rings; the printing is done on ⅜in. telegraph paper tape. An arrangement is made by which the wheel is slipped round and brought to zero once every minute. The speed in revolutions is printed in plain block figures. The time can be calculated by the length of the telegraph paper, though the printer is meant usually *for reading* at the time of experiments.

THE JOINT PARLIAMENTARY COMMITTEE ON ELECTRIC POWERS PROTECTIVE CLAUSES.

There is no doubt, judging from the formidable array of counsel and witnesses, and from the evidence given this week, that a very determined struggle will be made as to the use of the earth as return or partial return of an electric circuit, and as to whether the telephone and railway companies are to receive any protection in the matter.

The members of the committee are as follows: Earl Rosse, Earl Russell, Viscount Cross (chairman), Lord Clifford of Chudleigh, Lord Ker (Marquis of Lothian), Mr. Brunner, Mr. Forwood, Mr. Molloy, Sir Bernhard Samuelson, and Major Darwin.

In order that the drift of the evidence given in cross-examination, and which is summarised below, may be more readily understood, we append a list of the counsel for the various interests concerned:

National Telephone Company.—Mr. Pember, Q.C., Mr. Fletcher Moulton, Q.C., and Mr. R. Wallace.

Railway Companies.—Mr. S. Pope, Q.C., Mr. Fletcher Moulton, Q.C., and Mr. E. Moon, Q.C.

Electric Tramway Companies and Electric Railway Companies. Mr. C. A. Cripps and Mr. J. C. Graham.

Electric Light Companies.—Messrs. Deacon, Gibson, and Medcalf as agents.

Municipal Corporations of England and Scotland.—Mr. Balfour Browne, Q.C., and Mr. Worsley Taylor, Q.C.

Tramways Institute of Great Britain and Ireland.—Mr. Hans Hamilton.

Her Majesty's Postmaster-General.—Mr. R. Hunter.

Monday, June 19.

The **Chairman** called upon the first witness to represent the views of the Board of Trade.

Sir Courtenay Boyle, K.C.B. (permanent secretary of the Board of Trade) said that for several years the telephone company, and telegraph company, including railway companies using telegraphs, had sought for protective clauses in electric lighting provisional orders, and in tramway provisional orders and bills, so as to prevent interference with their circuits by tramways employing electricity for traction purposes, and by electric lighting companies using strong currents. Generally speaking, the telephone and telegraph companies used the earth as the return, but the General Post Office adopted metallic circuits for telephony. The action of Parliament on the matter was not uniform. Four clauses had been introduced, the effect of which was to give varied degrees of protection to the telephone company. The West Metropolitan had the most powerful clause. The lack of uniformity in those clauses, combined with the pressing demands this session of the telephone company for protection, had led to the representation to both Houses by the Board of Trade that it was desirable that Parliament should lay down the principle governing the amount of protection, if any, that the telephone company and telegraph companies were entitled to receive, and hence to the appointment of the committee. After defining various electrical units, the speaker said the telephone company used for conversation very small currents, something like one-millionth of an ampere at a pressure of a fraction of a volt; whilst generally the telegraph companies employed a current from $\frac{1}{100}$th to one-fourth of an ampere at from 10 to 50 volts. Electric lighting companies, on the other hand, used very considerable currents at from 100 to 10,000 volts. The high currents generally affected the telephones by leakage. Efforts were made to prevent leakage on electric tramways and to avoid any earthing. The tramways had tried to confine their circuits in the conductor and return, but it had practically been found very difficult to do that, as leakage took place. On the City and South London Electric Railway it had been found impossible to prevent leakage to earth, and the setting up of an earth caused an electrical disturbance in the neighbourhood, and which might extend for a considerable distance. There was no doubt that electric tramways did, and lighting companies might, cause electrical disturbances in the vicinity of telephone or telegraph circuits, and which caused material interference with the delicate instruments used by the latter two. The Board of Trade in provisional lighting orders had, except with special sanction, forbidden the use of the earth return. Passing on from a list of electric tramways and railways, the speaker observed that electric traction was growing in favour, and that its popularity would increase if the question at issue was settled. Dealing next with the case of the National Telephone Company *versus* the Leeds Corporation (Thomson-Houston line), he mentioned there were many instances in which considerable electrical disturbances had been proved, and of which Mr. Preece would speak. At Preston, arcing had been caused by the electric light conductors not having been sufficiently protected from earth. Certain gas and water pipes in the vicinity of the mains were materially damaged. From the point of view of the electric traction companies, it was urged that it was a simple thing for the telephone companies to make themselves safe by using metallic circuits; that the former could not protect themselves; and that therefore they ought not to be under heavy liability by using the earth. The telephone companies, however, differed on the matter. In reply to Mr. Forwood, Sir Courtenay Boyle said he would put in the printed report particulars of the systems sanctioned by the Board of Trade. When the earth was used as return in telephony, it followed that there was a certain amount of electrical disturbance, and perfect telephony would be obtained by the use of metallic circuits. In answer to Mr. Brunner, he stated that the number of tramway companies using electricity was very small, and as electric light companies were forbidden the use of earth, the danger of disturbances, etc., did not often occur; but if sanction was continued to be given for electricity for traction purposes, the number of instances in which there might be danger would increase. Replying to Earl Russell, the witness said that the tramway companies submitted that it would cost them a great deal to protect their systems, and that it would not necessitate great expenditure on the part of the telephone companies. On the other hand, the telephone companies contended that they had established a large system of great public interest, and that they should not be compelled to alter it. The Board of Trade had not studied American experience.

Mr. W. H. Preece, as representing the General Post Office, had given much attention to the matter because they had found that the Government telegraphs and telephones were gradually being disturbed. The disturbances arose from two causes: one was due to the passage of electric currents through the crust of the earth, and the second was caused by induction. The former was the most serious, but the effects due to induction could be easily removed with the expenditure of money. The earth had from the earliest stages, in 1837, been used as return in telegraphy. The first telephone fixed in London was arranged on a metallic circuit, but the companies, with the exception of on their trunk systems, used the earth, which was also utilised by the railway companies in the regulation of traffic and block signalling. The Government telephones were, however, arranged on metallic circuits. The earth had been permitted to be used by the London Electric Supply Corporation. With regard to the City and South London Railway, he mentioned that the return circuit was formed by the rails, and the tunnels also picked up some of the return current. The metals were not insulated. The diagrams which he exhibited illustrated what occurred when a train was about to start, and also what took place when two or three other trains were on the line. The earth currents extended to such a distance that they had disturbed the observing instruments at Greenwich, and had been also observed as far as North Walsham in Norfolk. Observations had been made simultaneously at the Post Office in the case of a portion of the Norfolk line and at Greenwich. Mr. Clew, a chemist, in Clapham-road, had in his window an instrument which recorded the passing of every train. That instrument was simply connected on one side to the gas-pipes and on the other to the water-pipes in his house. Mr. Preece had had the current measured. The voltage between Stockwell and the City sometimes reached three volts. At the shop in Clapham-road the pressure between the gas and water pipes was ·3 volt, and it gave a current of half an ampere. He would impress upon the committee the question of voltage found between the gas and water pipes, as it was by far the most serious disturbance. The effect of it, if not checked, would be that the water-pipe or gas-pipe, whichever was connected with the positive side of the current, would be decomposed away. Unless some steps were taken to prevent that, there would certainly be leakage of water and gas, and accidents would occur. He then referred to the electric lighting undertaken by the North-Western Railway in 1880 at Holyhead, and the first thing which happened was the breakdown of their block signals. After considering the protection which had been necessitated at Walsall, Blackpool, and elsewhere, and to that now required to be given for the block signals at Bray, he said that the effect of the earth currents had been that the moment a train stopped a powerful current was sent to the earth, and the block signal on a railway was lowered from danger to "all clear." That could, however, be prevented by adopting metallic circuits in the block sections. As far as the Liverpool electric railway was concerned, he had had measurements made. The metals there were planted on continuous wooden sleepers, they did not make very much earth, and the result was that the currents were very much less. He had not heard of any block signals being disturbed by the South London Electric Railway. The use of the earth should be subject to the supervision of the Board of Trade, as in the case of electric light companies, but he did not imply that the earth should be entirely discarded. He was not aware of any instances where attempts had been made to insulate the rails. The accidental use of the earth meant a considerable waste of energy and an increase in the working expenses at the generating station. Replying to Mr. Forwood, the witness could not speak from personal experience of electric tramway working. He thought if the rails on the City and South London line were laid on continuous wooden sleepers, the effects of earth currents would be materially reduced. He did not consider the telephone service complete until it had metallic circuits, but it would financially be impossible to double the telegraph system. If all electric railways were started as now projected, the telegraphs would be injured. He thought with proper supervision it was quite possible for every tramway in England to use the earth accidentally without disturbing the telegraphs. The Post Office had about 7,000 telephones, and were now erecting between 4.000 and 5,000 miles of wire, with extensions to 20,000 miles. What he meant by accidentally, was that tramway companies should design their systems so as not to use the earth intentionally as return. Alternating currents would not affect gas and water pipes, but direct currents would. In some outlying districts in Ireland and Scotland the Government employed single wires for telephony; they were short lines and did not come near the telegraphs, but in large towns where other circuits existed, metallic circuits were used.

TUESDAY.

Mr. W. E. L. Gaine (general manager of the National Telephone Company), on examination by Mr. Pember, deposed that the National Telephone Company carried on its business under license from the Postmaster-General, that the license was for 31 years, and that it expired in December, 1912. Several companies had been formed for telephonic purposes, but they were now under the control of the National Company. Several isolated exchanges were conducted by the Post Office. The company was sending over 2,000,000 messages per annum at an average cost of about ½d. per message, and had 506 exchanges, 60,155 exchange and private lines, and 90,746 miles of wire. The witness then gave examples of the magnitude of inter-town communication, and particulars of charges for rental and for long-distance conversation. Two large maps arranged on the wall gave a general idea of the running of the trunk wires, and of what trunk communication between two large industrial centres was. With one or two exceptions, the exchanges had been built up on the earth-circuit principle, and he pointed out that that system was on the lines of those used in the United States, France, Germany, and nearly every country in the world. He, and also the directors, held the strongest opinion that the earth return was amply sufficient for all commercial purposes where subscribers could be concentrated in one central exchange, and for local purposes only that method would give an efficient service. This statement the witness qualified by saying that for long-distance telephony metallic circuits had been adopted by the company; in fact, the service was arranged to meet the particular purpose in the most suitable manner. Metallic circuits would commercially be unremunerative for local exchanges. As the development in London had not given a service to which subscribers were entitled, the company had during the past few years spent huge sums in order to remedy the matter and to get the junction wires between the London exchanges on a metallic circuit, and the subscribers were now being connected in that manner. The company had in London an area of 500 square miles and 23 exchanges. He qualified the commercial capabilities of the single-wire system as follows: Where the subscribers could be concentrated into one exchange then for local purposes that method was sufficient, but with a large area like London, where subscribers constantly had to pass two or three exchanges to converse with the people they desired, and where subscribers to one exchange called for subscribers on other exchanges, then a metallic circuit was undoubtedly an aid to an efficient service. If the Leeds Electric Tramway was planted in Liverpool that day, the Liverpool people would be deprived of the telephone for five or six years. An enormous expense would be incurred in duplicating the system, a switchboard alone of the size used at Liverpool costing £20,000. The adoption of metallic circuits would imply the rearrangement of the whole system. Assuming that electric traction was general, the cost to the company in rearranging their system would be about £2,000,000.

By **Mr. Cripps**: A very small portion of the system was worked on metallic circuits; Newcastle and Hull were on the latter method, the reason being that nearly all the wires were underground. Where underground wires were necessary the telephone system was not so perfect. The annual rental in Newcastle and Hull was £10, and in Liverpool also £10, using the earth return. In London £17 per annum was charged for five years and £20 for one year. Asked if electric tramways had not perfect insulation, whether a metallic system would be necessary, the witness replied in the affirmative. If the whole telephone system was arranged on metallic circuits, where there was no question of cost and time, and reasonable precautions were taken by tramway companies, there would be no disturbance in the telephone system. In London the whole of the junction wires between the 23 exchanges had been altered, and some of those of the subscribers' had been replaced. About £100,000 had up to the present been expended on those alterations, which had improved the system. The annual rental in Paris was £16, and the subscribers had to provide their own instruments. Apart from the South Staffordshire line, the witness was not aware of any place where the telephone clause applied with a tramway at work. Metallic circuits were used in the United States for long-distance telephony, but the principle of working there was first, second, and third class—first-class being long-distance.

By **Mr. Balfour Browne**: Some complaints in connection with the Walsall Electric Tramway had been made of interference with the telephone wires. He was not aware that the Corporation there and also at Blackpool were prepared to give up telephony rather than electric traction. He knew that the Postmaster-General had decided that no further licenses would be granted without the adoption of metallic circuits. The New Telephone Company was not amalgamated with the National. It started with the intention of providing metallic circuits for £12. The Mutual Telephone Company of Manchester was taken over by the New Telephone Company, and a large portion of the shares in the latter was purchased by the National Company, whose capital was £4,000,000. The price paid for those shares was £5, on which £4 had been paid. The National Company had absorbed 13 licenses. A rough estimate making a complete change to a metallic system of was £250,000.

By **Mr. Pember**: The National Company paid to the Government an annual royalty of £55,000. Both the Walsall line and the City and South London Railway were worked under the protective clause. Witness then answered questions put by the committee.

Dr. John Hopkinson, examined by Mr. R. Wallace, explained the use of the earth and the difference between the currents used in telephony, telegraphy, and electric lighting. When properly carried out, electric lighting did not cause any interference. The light companies were authorised to supply current for motive power, but he did not know whether they were permitted to do so for tramway working. He described the operation of the Leeds tramways. The power at starting was about 20 h.p., which gradually fell until the normal was reached. On telephones there he had heard the disturbing noise which rose, and fell, and vari in pitch. The noise prevented his hearing through the instrument; he could hear a car starting, and sometimes two, on the line. The witness thought the London telephone system was now sufficiently good for practical purposes; the system had improved as compared with the past, and no doubt with the changes that improvement would continue. As regarded traction, with the use of two overhead insulated wires, no mischief would result if an accident happened. He had only seen two lines where both conductors were insulated; one was on an old overhead system at Vevey-Montreux, and the other was on the slot method at Budapest, where there was 6·82 miles of double line. He had listened at the telephones there and had heard absolutely no disturbances, and he was satisfied that the slot system used was a thoroughly practical working scheme, and would yield a return to the shareholders.

By **Mr. Moon**: He described the working of the block system, and confirmed Mr. Preece's statement regarding the lowering of the block signals. At Blackpool he had twice seen the signal pulled down from "danger" to "all clear" without the intention of the signalman. The remedy was the insulation of the tramway, and if both conductors were insulated the only thing which could happen, and of danger to a railway was through an accidental earth. With proper insulation of electric tramways and the use of simple instruments, no danger could ensue to railways in the neighbourhood.

By **Mr. Browne**: The currents used on electric tramways might and did alter railway signals; and the introduction of metallic circuits on railways between the signals would obviate the action of the tramway. The method at Vevey-Montreux was antiquated, and would not now be used. He opined that overhead wires as at Leeds would not be permitted throughout this country. In the case where tramways entered large towns he would adopt substantially the same system as at Budapest.

By **Mr. Cripps**: He did not advocate overhead wires in towns; they might be used in country districts. He suggested the adoption of the slot system in some form or other, and he would insulate both the positive and negative wires. The insulation on that system could be depended upon very fairly. He had heard of tramways being worked with double conductors in the United States. By placing the two wires close together and insulating them, induction would be obviated. He opined that more interference on telephones took place from induction than by leakage. If the tramways were to insulate both conductors and use instruments at their stations telling them at once of any single earth contact on their system, the railway companies would be safe. The City and South London line worked wonderfully satisfactory.

By **Mr. Hans Hamilton**: The witness did not advocate the use of accumulators as a commercial possibility. As long as the telephone company had no power to break open the streets and lay wires he would object to doubling the wires overhead.

Dr. E. Hopkinson, called by Mr. Pember, said that he had been asked to prepare estimates for an electric tramway three miles long. The first, on the same lines as that at Leeds, with earth return, would cost £14,251. The second, for a completely insulated return, with a pressure of 600 volts, would necessitate an expenditure of £12,698. The third, with insulated return and a pressure of 300 volts, would cost £14,665. Those estimates did not include buildings, but only the plant, and his company would undertake contracts at those figures. Since preparing those estimates his company had accepted a contract for equipping a tramway in the Isle of Man, 2½ miles long, with double conductor. The estimates were on the basis of overhead wires.

Lord Kelvin, examined by Mr. Pember, remarked that the use of the earth return had been successful in the case of telegraphy and telephony. The system had been seriously interfered with in a few instances, but the only case of disturbance in telephones, other than by tramways, was in the case of the electric lighting of a train in Glasgow, and to which he referred in detail. He thought that restrictions should be imposed with equal propriety on both parties. If an electric tramway was short, considerable disturbance would be set up over a distance of many hundred yards, and disturbances would be perceptible five or six miles distant. In conjunction with Sir Frederick Bramwell, he inspected the Leeds tramway last year to see the effect of its working upon the telephones. There was considerable disturbance, and he found it almost impossible to converse and hear at certain times during the running of the trams. He attributed the disturbance partly to leakage and partly to induction, and thought that something in the way of a brush contact might obviate the difficulty. The most effective method was to use a properly insulated return wire, and that there was no difficulty in obtaining that result. He considered that the tramway wires should be placed underground in towns. In some cases it would be found that the best plan was to use two insulated conductors, which allowed of the employment of a much higher difference of potential than when the whole system was confined to one insulated conductor and the earth. Accumulators had been tried in some cases with success, but he could not prophesy whether that method would ultimately become commercially satisfactory. In many respects it was to be preferred to insulated conductors and generating and transmitting the current a distance. He considered it would be a great evil to the public if the overhead wires were doubled.

By **Mr. Cripps**: The claim of the telephone company was to be allowed to continue the use of the earth undisturbed as heretofore. When the telephone system was started 13 years ago there was no question as to its being disturbed. The question of protection had arisen since the application of other systems, as electric traction. His Lordship considered that the use of the earth for both telegraphy and telephony was very valuable, and he thought it would be a great inconvenience to the public which would introduce a system which would be necessary to introduce metallic circuits for all telephones. The tramway companies might find a way of working without interfering with the telephones. As to induction, he agreed with Dr. Hopkinson that it was quite as deleterious as leakage. With two insulated conductors side by side there would be very little induction. He considered twin wires were necessary between telephonic junctions in some parts of the system. If the doubling of the wires was carried out overhead it would be very objectionable, but by undergrounding a metallic system the objections would be overcome. Apart from expense and overhead wires, a better service was obtained by using a metallic system.

At the close of the day's evidence the **Chairman** said that the committee had decided, in consequence of a representation made by the gas and water companies consequent upon Mr. Preece's remarks as to the use of gas and water pipes as part of a return circuit, to hear counsel and witnesses on behalf of those companies.

Wednesday.

Dr. J. Hopkinson, at the request of the chairman, explained the action of the transmission of a telephonic message. There was no doubt that deleterious effects were caused by electrolytic action on gas and water pipes. That was true theoretically, and it had been found in practice in the United States that the effects were so serious that gas-pipes had actually been eaten through in a very short time during which the electric tramways had been at work on a very large scale.

Mr. D. Sinclair (electrician-in-chief to the National Telephone Company), on examination by Mr. Fletcher Moulton, observed that the local wires in Glasgow were on the earth return system, and that the service in London was not so good because London was really a series of towns connected together. A mixed system of single and twin wires could not be worked from exchanges, and in changing from one system to another, the twin wires would remain idle until the entire change had been effected. An alteration of the Liverpool system would require five or six years; a metallic circuit would have to be erected and the single wires then swept away entirely.

By **Mr. Cripps**: Single wires were used in Glasgow, and also a metallic circuit to a limited extent. Both systems were in use at Stockholm, and considerable difficulty was experienced in working on the two methods. The whole question of combining the two together was one of degree or proportion; about 10 per cent. earth could very well be worked with the remainder of the lines arranged on a complete metallic circuit. None of the wires in London on the metallic system had yet been put to work. The witness was unable to state how many faults occurred in London; some of them only lasted a brief period. There were more complaints now of faults whilst the system was being changed than there were before operations in this direction were commenced. Every operator could connect any two wires in an exchange, and the maximum number of wires he had seen in in an exchange on the multiple system was 6,000. The telephone company in London used both the earth return and the water-pipes.

By Members of the Committee: If electric traction largely increased in London, the difficulties of the telephone company would be augmented, and to the extent that subscribers would not be able to hear, and whilst the system was being reconstructed telephonic communication would be stopped, as was the case at Leeds. He regarded the tunnels of the City and South London Railway as being as good as a copper conductor, and said that the amount of trouble caused to the telephones by that railway had not been serious, and the leakage did not affect the working of the telephone wires.

Sir Frederick Bramwell, on being examined by Mr. Wallace, said he believed that the exercise of the telephonic industry was carried on without injury to any other existing system. The disturbance at Leeds was intolerable, one losing as many words as one heard; and at the Roundhay call office hearing was out of the question He did not know of any practical mechanical difficulties in the way of designing a completely insulated underground system of tramway traction, and he believed, once for all, that the increased capital expenditure thereby necessary would only amount to a small percentage on the total. The tramways would get in that manner a better principle of working.

By **Mr. Balfour Browne**: He could, if necessary, instruct the tramway companies how to carry out such a system, although he had not seen in operation a tramway where two wires were used. The disturbance in the telephones at Leeds was due to both leakage and induction, but he could not state the amount of the leakage.

By **Mr. Cripps**: The electric light companies were supplying but little current for motive power purposes; he knew of a lift being so worked, and of a machine for washing currents. If the telephone company was treated in the same manner as the Post Office, the former would have the protection which they wanted.

By the **Committee**: He regarded the City and South London Railway as having a metallic circuit. At Leeds there was a considerable difference in the contact; by using a brush, that might be improved. As to the cost of a metallic return, he thought it would be about 6 per cent. on the total outlay; and if a metallic system was adopted on tramways, it would avoid the injury to gas-pipes.

Mr. W. Howard Winterbotham (solicitor to the National Telephone Company) was called by Mr. Pember. The witness was examined at considerable length concerning the attitude taken up by the company since 1885 in regard to protective clauses, etc., in electric light and power and tramway Bills and orders, there being, among others, those referring to Lea Bridge, Wellingborough, Walsall, Birmingham, Leeds, Salford, and Folkestone.

By **Mr. Balfour Browne**: He could not say the amount of capital expended in telephony, and he and the telephone company had not led tramway companies and corporations to believe that the protection clauses were really Board of Trade clauses and would be inserted in all Bills asking for electric traction powers. Various Bills or orders had been dropped on the insertion of protective clauses.

By **Mr. Cripps**: The decision in the Leeds case was against the telephone company. He had not on behalf of the company threatened proceedings against the South Staffordshire Tramways Company. A letter had been written to the company a year before they commenced working the tramways by electricity, and when the telephone company knew that the lines were to be operated in that manner, pointing out and enclosing copy of the protective clauses, and suggesting that the tramway company should be on their guard. The various clauses had all been against tramway companies or corporations. The telephone company had never been before a parliamentary committee to ask for statutory powers, and tramways or corporations had not sought protection against the telephone company; it had always been the telephone company against other parties.

By the **Committee**: The telephone company had opposed 52 orders, and most of them had obtained powers subject to the protection clauses. The City and South London Railway and the Liverpool line were working under the clauses, and more lines were in operation under them than otherwise. Birmingham was not, neither was Blackpool, but the latter had this year accepted the clauses; Leeds was not, South Staffordshire was, but the Giant's Causeway line was not under the clauses. In reference to a list handed in to the committee concerning those authorised to use power other than that of horses, the witness said that mechanical power was supposed to include electricity.

Mr. J. Staats Forbes, examined by Mr. Pember, endeavoured to show that the alleged advantages of metallic telephone circuits in large towns were simply a theory; that system would not produce the great advantages supposed. As an instance of the utility of the single-wire system, he mentioned that whereas great increases had taken place in the telephonic business of the company where it competed with the Post Office telephones, the business of the latter had diminished. This he illustrated by citing various examples. He opined that the public would have to pay the cost of altering the system, and stated that the company's license only now extended for a period of 18½ years. The company had expended a considerable sum of money on building up the system, and it would become a question whether it was worth while spending more money to the extent of hundreds of thousands of pounds, especially as he had reason to believe that the Post Office intended to purchase the system at the expiration of the license, and as the purchase price had been fixed by the Post Office at about £1,000,000, when the company had expended about £5,000,000, which had to be got back in 18½ years. It was not necessary to spend more money, and the company got on very well with the single-wire system. The reason the wires were being duplicated in London was because so much difficulty was experienced in getting across and around property, and owing to that three exchanges were sometimes required where only one should have been actually necessary.

By the **Committee**: About 13 companies had been acquired by the National Telephone Company. There was no doubt that the capital of the company was considerably greater than that expended on structures.

Mr. Aspinall, examined by Mr. Moon on behalf of the railway companies, said that he was chief mechanical engineer to the Lancashire and Yorkshire Railway. He described the six sets of wires, telephone, telegraph, etc., carried along the railway, and stated that the total cost of duplicating the system would amount to £48,300, and that the cost of maintaining the system would be £7,900 per annum.

By **Mr. Balfour Browne**: Electric tramways would affect the lines wherever the former were started. His company wanted the tramways to duplicate their circuits so as to prevent the possibility of leakage. Without that was done the £48,300 would not alone protect the company's lines. He was not aware of any postal telegraphs being interfered with by an electric tramway. The only danger to the public likely to be caused by the latter would be in affecting the block signals and bells, and not the other wires and instruments.

By **Mr. Hamilton**: He did not think, if the telegraphic instruments were used frequently, that they would materially interfere with the telephones; there would be a little tick, tick, but that did not prevent one from hearing. The company regarded it as most serious for a leakage from a tramway to get into their system of wires.

Mr. Fletcher (principal assistant to the electrical engineer of the London and North-Western Railway), called by Mr. Moulton, deposed, from his experience at Walsall, that there was serious interference caused in the railway company's wires. He did not think that the arrangement of connecting the negative pole of the dynamo to the water-pipes, as adopted at Walsall, should be permitted to continue. The disturbances set up by the electric tramway there had compelled the railway to adopt metallic circuits. Special appliances would have to be introduced if the company was to readily detect leakage.

By **Mr. Balfour Browne**: If the railway could not have the use of the earth, metallic circuits would be the best. There had not been any disturbances in the wires at Walsall since the introduction of the twin-wire method.

By **Mr. Hamilton**: If the tramway company used current at 300 volts the effect upon the wires would depend upon the nature of the ground. The telegraphic current would to a certain extent interfere with the telephones.

THURSDAY.

Before the proceedings commenced yesterday the members of the committee inspected the telephonic switchboard at the offices of the National Telephone Company, in Cannon-street.

Mr. Langdon (superintendent of the telegraph department of the Midland Railway) confirmed the statements previously made concerning the disturbance in the company's wires at Walsall, where the Midland Company used the same lines as the London and North-Western. The only manner of rendering railway working safe would be by disassociating the high currents from the earth; that was imperatively necessary. The provision of a single return for a number of railway wires was erroneous. He illustrated, by the exhibition of a block instrument, how the needles of such instruments had been affected at Walsall. The railway company only wished to protect its property, and he considered that no one had a right to a monopoly of the use of the earth. Heavy currents, if the return was not insulated, would monopolise the earth and drive out all others.

By **Mr. Hamilton**: The Midland Company had 6,000 miles of wire used for block signalling purposes, and to place one-third of them, which he thought would be necessary with the general use of electric tramways, on a metallic system, would necessitate an expenditure of £17,000 or £18,000.

By the **Committee**: If the tramway companies used metallic circuits and the railway companies' wires were still affected, he thought it would be necessary for them to adopt twin wires. The use of metallic circuits by both would be most effectual in overcoming the difficulty, but only half protection would be afforded by one interest using complete metallic circuits.

Mr. C. E. Spagnoletti, called by Mr. Pope, said that he had for 37 years been electrical engineer to the Great Western Railway. He considered the best system for a tramway company was to use an insulated conductor, both for the outgoing and incoming current. Of course, some provision—a kind of makeshift—could be made for a time without the adoption of an insulated return, but to ensure security, a metallic circuit would be necessary. If placed on a twin circuit, the railway wires would be more sure. He did not consider it would be sufficient for the railway company to adopt metallic circuits and for the tramways not to do so.

By **Mr. Hamilton**: Personally the witness had not made any experiments as to the disturbances set up by electric tramways. He did not think, supposing tramway companies laid an uninsulated metallic return, and the railway companies insulated their return circuits, that there would be any interference with the telegraphs so long as the insulation of the latter remained perfect.

By **Mr. Wallace**: A disturbance in the wires of the District Railway took place last October, and it affected the working of the system between St. James's Park and Sloane-street. That interruption was caused by an accidental leak. It was ultimately found to be due to the fact that at the generating station of the Westminster Electric Supply Corporation the armatures of the dynamos had short-circuited through the earth. He agreed with Mr. Langdon that metallic returns for both interests would be the best.

This terminated the evidence on behalf of the railway companies.

(To be continued.)

THE TEAGUE METER.

SIR,—In your leader of June 9th you make certain remarks respecting the Teague electricity meter, by which it is apparent that both the writer of the article and Prof. Perry are not familiar with its construction.

I beg to inform you that the "physical law of change of viscosity of liquids due to change of temperature" has not at all been "overlooked," but that, on the contrary, means have been adopted which render the Teague meter quite independent of outside temperature variations. This object is attained by the use of a special shunt of German silver or platinoid wound non-inductively and put into circuit by a thermostatic strip and contact whenever the meter is below its working temperature. The shunt is of such a resistance as to readily warm up with the passage of the current, and is placed close to the glycerine, the result being that the viscosity of the latter is always constant, as the temperature is constant. I may add that the glycerine, besides acting as a fluid brake, also prevents the oxidisation and consequent change in friction of the mercury, and without this protection no mercury meter can give accurate readings for any prolonged periods. I am afraid that the absence of the Teague meter in the market has been prejudicial to its interest, and has no doubt led to surmises that defects had developed themselves; this is by no means the case, and I am confident that it has an important future, the absence referred to above being solely caused by temporary difficulties arising through legal proceedings with reference to the proprietorship of the Acme Electric Works.—Yours, etc.

FRANCIS TEAGUE.

London, N.W., June 15.

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HAY v. ELECTRICITY.

The long-continued dry weather in this country and on the Continent may not have been considered to have any connection with electrical work, but a little thought will show that it may. In our opinion, electric traction, though slow in getting a strong footing in this country, is bound in the long run to become the foremost branch of the industry. Consider for the moment the cry of the tramway authorities : Give us electric traction at a cost equal to that of horses, and we will adopt it. That is so far as new lines are concerned, but with old lines the question of change means expenditure of capital where there is no capital to expend. But what is the outlook? For years the supply of horse provender has been fairly cheap, and the cost of horse keep therefore almost or quite as low as it could be, thus putting electricity in competition with horse traction under somewhat impossible conditions. It seems, however, pretty clear that hay and straw will during the forthcoming winter fetch much higher prices than during any period of the last decade, so that the cost of horse traction will go up while the cost of electric traction has been steadily decreasing. The purveyors of apparatus for electric traction should therefore be doubly energetic, and push their wares with vigour. In many cases the adoption of a self-contained car is a necessity. We are not among those who say this is an impossibility. No doubt there have been trials and failures of accumulators, but that was only to be expected, and the electrical engineer who despairs of providing an accumulator suitable to fulfil the requirements of electric traction is unworthy of being reckoned among the fraternity. During the past twelve months successful experiments have been made in lighting omnibuses by means of accumulators. Now, such accumulators probably have a rougher time than accumulators used for traction. The former are, to begin with, more fragile; they are handled in a careless manner by men outside the employ of the electrical companies; they are subjected to greater jolting; and yet success has certainly been achieved. It would not do for us to consider the question of cost as being the only question to decide the use of electricity for light in this case. The cost may be, possibly is, higher, but the comfort is commensurate with the increased cost. The demand upon a traction accumulator is, however, very different to the demand upon a lighting accumulator. Assume the difficulties arising in obtaining mechanical strength against rough usage to have been overcome—as it must have been overcome in these lighting batteries—is it possible to provide batteries mechanically strong which have the required discharging rates for traction purposes? No answer except in the affirmative can be given to such a question. What a pity it is that the trials, the failures, and the successes have been kept so secret. Tons of accumulators have been tried, and put away. Why? Neither makers nor users will say—at least, not fully. The makers try to keep everything secret, and continue quietly to make improvements—a policy which has its advantages, but, we are inclined to think, leads the public generally to imagine that accumulators are really altogether out of the market. It is not beyond the powers of the electrical engineer to combine weight, strength, capacity, and rate of discharge so as to give the tractive power desired at a cost which should not be thought excessive. With the increased cost of provender, especially if such increase continues for a tolerably long period as the present forecast points to, the tramway authorities will look more and more closely into the possibilities of electric traction. Some, if not all, of the prominent makers of accumulators will be ready to guarantee results which will probably lead to business. Thus far we have spoken of the least favoured form of traction—that form which has made least headway—but which seems to be the system most suitable if it can be rendered effective and fairly economical on many of the English lines. With regard to overhead conductors or conduit systems, these will be very prominent to our readers because of the joint committee sitting to report on the position of this class of traction in regard to telephony. Our text is, therefore, confined to, the increased cost of horse provender must be taken into account by the tramway authorities. With this increased cost they will be led to look more favourably towards electricity; electrical engineers can provide even self-contained cars, which, so far as regards mechanical strength and electrical requirements, will fulfil the conditions required, and this at no excessive cost.

THE GAS ADVOCATE.

We are anxious that Mr. Denny Lane should have every opportunity of defining his exact position and explaining his remarks, therefore we heartily welcome his letter to us. With regard to the malodourousness of gas we shall never agree. To us both gas and oil are stinking nuisances—yet we at present use both. The nuisance is a chemical question, and to discuss it profitably we would have to consider the unconsumed gas and the products of combustion of the consumed gas. All our sanitarians agree that an atmosphere containing unconsumed gas, or carbonic oxide, or carbonic dioxide, is hardly to be reckoned as healthy. It is seldom we go into a room lighted by gas without detecting the smell. However, the more important point is what Mr. Preece meant. Our interpretation is not the same as that of Mr. Denny Lane. No doubt Mr. Preece will take an opportunity of saying which is right. Mr. Preece said—inaugural address, *vide* our issue, Feb. 3, page 135—" If a full load could be maintained during the whole twenty-four hours, electrical energy could be manufactured for one-third of a penny per supply unit, and this is equivalent to gas at 2d. per 1,000 cubic feet." Our rendering of this is that with the best modern apparatus—that is, the best boilers, engines, dynamos, etc.—1,000 watt-hours, or one supply unit, or about 1⅓ horse-power hour, can be *manufactured*, not *sold*, for one-third of a penny. Mr. Preece was discussing the bed-rock cost of manufacture—nothing more. The loading to be put upon one-third of a penny before the possible selling price is reached is another question. We do not believe that a single person in Mr. Preece's audience took him to mean that under any circumstances could a kilowatt be sold for one-third of a penny. Our objection to Mr. Lane's address is that it seems the work of an advocate rather than that of a fair critic. He might, for example, have seen that another and safer interpretation than his could be placed upon Mr. Preece's words, and his selection of examples relating to electric lighting seem to us so evidently intended to give the worst impression possible that we have been led to deal so prominently with the address.

CORRESPONDENCE.

" One man's word is no man's word,
Justice needs that both be heard."

PROF. PERRY'S METER.

SIR,—My attention has been called to a description of Prof. Perry's meter in your number of the 9th June, and to your article on the same subject. Would you allow me to place the following passages from your paper side by side with quotations from my patent No. 4,225, of 1887, and from a paper of mine, read in November, 1888, and printed in the *Philosophical Magazine* for February, 1889 :

" A word as to the magnets used will be interesting. One objection to the use of permanent magnets is the gradual decrease of strength often noticed by lapse of time. This is obviated in an ingenious way. The blocks of separate magnets, in hardened steel, are put together, and a coil is placed in the interior. The magnet poles are connected across the top. An enormous current, sufficient to make the coils white hot, if continued, is passed through for about 10 seconds only, and this magnetises the steel bars to their utmost capacity. . . . The permanent state so obtained has a tendency still more to slightly increase, and this balances the ordinary tendency for the magnetism to diminish by lapse of time."	" The current by which the circuit is magnetised is always applied when everything is in position ; otherwise very small intensity results. The magnets are flashed by a current from a dynamo to practical saturation. The coils are then removed, and the magnets hammered severely. The hammering seldom reduces the intensity more than 1 per cent. In months of continued testing I have never found any measurable falling off in the field of a magnet so treated. If a reversing current is applied, the intensity will spring up on removal of the current, and will sometimes continue to rise appreciably for a considerable period." — *Phil. Mag.*, Feb., 1889.
" The magnet poles between which the copper revolves, instead of being symmetrical, and the field even, are made toothed, and the field is therefore in parts very strong, and then much weaker alternately. The rotation of the copper from strong to weak field generates considerable eddy currents, and it is the electromagnetic friction so produced which opposes the rotation of the copper cup, and renders the readings proportional to the current at no matter what temperature. The adoption of this ingenious expedient due entirely to Prof. Perry, etc. . . ."	" It is of importance to increase as far as possible the magnitude of these eddy currents. In order to do this, I form the pole-pieces with grooves in them. . . . The said grooves increase the retarding action of the brake disc." Claim 7 runs as follows : " Making grooves in the pole-pieces of the electromagnet or permanent magnet of an electricity meter for the purpose of increasing the action of the brake substantially, etc. . . ." Patent No. 4,225, 1887.

—Yours, etc., GEORGE HOOKHAM.

Birmingham, June 20, 1893.

"THE GAS ADVOCATE."

SIR,—I have just seen your article entitled " The Gas Advocate," in which it seems that you find more to blame in my " figures of speech " than in my " figures of arithmetic," and as you have been good enough to print a large and important portion of my address to the Gas Institute, I feel you have allowed your readers to hear something of the other side of the question, and I thank you for doing so.

There are, however, two statements of fact in your leader which I must take the liberty to contradict. The first is that there can be "no bigger sanitary curse than a half-turned-off gas jet. It is a stinking nuisance."

Now I have lived in gas-lighted houses for over half a century. For over 37 years I have been intimately connected with the manufacture, distribution, and use of gas, and I have *never* met with any *lighting* burner that gave any unpleasant smell if turned down to even one-tenth of its usual consumption. In my office I have a 5ft. burner which is left burning all day in winter, then using perhaps one-twentieth of a foot per hour, and when thus used there is no smell whatever from it.

With some Bunsen burners used for *heating* it is different. If the primary supply of air (used to dilute the gas and thus prevent the formation of carbon particles in the flame) be too large for the gas supply, an imperfect combustion takes place within the tube instead of at its upper orifice, where it meets the secondary supply of air which completes the combustion. With well-constructed burners this cannot occur, and I have entered laboratories where many such burners have been burning for hours without finding any smell whatever. Even with the ordinary kind, if the supply of gas be in proportion to the supply of air, the occurrence of "striking back" cannot take place, and the products of imperfect combustion (some, I believe, of the acetylene series) will not be evolved.

With reference to Mr. Preece, I have quoted his exact words as given in the *Transactions* of the society of which he is president. Surely "supply unit" cannot mean anything else save the unit supplied, and nothing to do with horse-power. Whatever Mr. Preece meant, he clearly told his audience and the public that a kilowatt—say, 1⅓ h.p.—could be supplied for one-third of a penny. Surely he could not mean one thing, and mean his audience to believe another thing.

I am no enemy of electric lighting. I have done my best to introduce it into this city, and by showing that gas may be made useful with reference to the two great difficulties electricians have to encounter—viz., storage and distribution—I have sought rather to encourage than to injure the spread of electric lighting. I am indeed gratified that Prof. Kennedy has advocated for Belfast the very system which I have for many years recommended.—Yours, etc.,

DENNY LANE.

Cork, June 20.

THE ROYAL WEDDING.—ELECTRIC LIGHT v. GAS ILLUMINATIONS.

SIR,—In the interest of the electrical trades, perhaps you will spare us a small space to call the attention of electricians to a very pretty and economical method of electrical illumination, which can be easily carried out by those having current at hand on the premises for supplying the electric light. Very few people are aware of the pretty effects to be obtained by the following simple plan: Get a small electric motor, such as supplied by the Edison and Swan Company, Messrs. Mackey, Mackey, and Co., Woodhouse and Rawson, and other well-known electrical supply firms, and on the spindle of the motor fix, say, a Venetian window blind lath, or double spade wooden propeller, when duplex effects are required, upon which is studded five or six incandescent lamps, the glass and holders being of different colours. This, when rotated, would form an "electric wheel," which can be fitted up outside any convenient part of the premises to be lighted, the current being supplied by wires from the main branch leads, in the usual way. When the appliance is complete, and the motor started to revolve, the blades holding the lamps will produce beautiful rings of incandescent light, and most pleasing effects are obtained for the small amount of money expended. The current consumed for a whole evening display for working such an "electric wheel" of 3ft. to 4ft. in diameter does not exceed, say, 1s. Another very pretty arrangement is to stud the propeller with variegated lamps, which, if placed in different parts and various positions on the fan blades, controlled by a plug switch fitted inside the building, the motor and the wheel can be operated to produce very marvellous and brilliant effects, putting gas illuminations entirely in the shade. Connections to lamps can be easily obtained by fixing at the back a spiral spring commutator to feed the lamps at the back of the revolving fan, a plan which any electrician can construct to meet general requirements. We may say we carried out several displays of this kind on her Majesty's Jubilee in various parts of the country which were much admired by the million. Those possessed of an electric motor with current at command can easily arrange such an illumination, or the current can be easily tapped from a neighbour's main, or laid on from central-station supply. We strongly advise them to try this novel and pleasing method of illumination, even if a motor has to be purchased for the occasion. A small one of ⅛ h.p., costing but a few pounds, will suffice, and is ample to drive a light-made wooden electric wheel of 6ft. in diameter. The motors after the occasion will be found most useful to drive one of the modern air propellers to ventilate the building, or for working other small machinery, so the money paid for the motor would be well invested. In districts where current is unobtainable, the plan can be carried out by having a small motor wound for four, eight, or ten volts, which can be driven by a few storage or primary batteries, and results obtained nearly as good in this instance as if the motor were driven from the electric light mains.—Yours, etc.,

SHIPPEY BROS., LIMITED.

REVIEWS.

Dynamos, Alternators, and Transformers. By GISBERT KAPP, M.I.C.E., M.I.E.E. London: Biggs and Co.

Mr. Kapp's new book is written for the purpose of placing before the reader an exposition of the general principles underlying the construction of dynamo-electric apparatus, avoiding the use of high mathematics and complicated methods of investigation. That the work is of a high order, and contains a large amount of matter valuable alike to the average engineering student, and the average practical engineer, is certain, but as opinions must always differ more or less regarding the best method of setting such matter in order, we may be permitted to say that here there appears to be left some room for improvement in future editions.

In the first chapter Mr. Kapp defines the dynamo-electric machine, and proceeds to compare its efficiency with that of other machines for the transformation of energy, but the description of a complicated structure like the Victoria dynamo, coming as it does on page 17, and before the reader knows anything about magnetic fields or E.M.F.'s, seems out of place. The particular kind of practical engineer the author had in mind when penning this chapter we have not yet met, and a careful perusal of the work indicates that the error of proceeding from the complex to the simple instead of from the simple to the complex, is not confined to this particular chapter. The attempt to define the difference between a dynamo and an alternator by reference to the Brush machine is also somewhat unhappy; indeed, to the ordinary engineer, knowing nothing of electrical work save what Mr. Kapp has told him in the first 19 pages, we fear that pages 20 and 21 would be perfectly inscrutable.

The next four chapters deal with elementary principles setting forth everything very clearly, and giving, instead of the merely supposititious examples so prevalently met with, real examples from real dynamos. For instance, at page 64 we have the downward magnetic pull on an upright type dynamo worked out, and at page 85 the torque on an armature carrying 400 amperes. It is to be regretted, however, that Mr. Kapp employs a somewhat cumbrous method of calculating the exciting force from equations containing the permeability instead of adopting the simpler method of taking the force required for each particular piece of the magnetic circuit as a function of the induction. Of course one ought to be able to apply all formulæ equally well; at the same time there is a neat and a cumbrous way of expressing the truth, and we certainly think that Hopkinson's expression, neat by comparison, is preferable to Kapp's formulæ on page 111.

Chapter VI. deals with the magnetic properties of iron, experimental determination of permeability, energy of magnetisation and hysteresis, while Chapter VII. treats of induced E.M.F.'s, the C.G.S. unit of resistance, and so on. The student at the end of Chapter VII. is treated to the description of a Gramme armature without any engraving to help him, so the author at this stage may be assumed to credit the reader with a good deal more knowledge than he has obtained from the preceding pages. But the omission strikes us as being unfortunate, for either the description ought to be rendered quite clear by a block, or the "few words of general explanation" left out altogether. In Chapter VIII. are explained the different methods of armature winding, the device of cross-connecting, and the danger arising in multipolar Gramme machines from the generation of parasitic currents consequent on the armature getting a little out of centre. This is a very valuable chapter, but we must confess that the reason for describing the multipolar series ring winding in terms of, and as evolved from, the multipolar series drum winding, is by no means clear. This only complicates matters, as the former was *not* evolved from the latter in fact, nor should the student be called upon to imagine it in theory. It would be far better, and the description would be rendered more intelligible, if the one winding were described without reference to the other; there is no real relation between them, and no necessity to invent one. In Chapter IX. the author *arrives at* the construction of the Brush armature, but, alas, for the practical engineer, there is no diagram given of the Brush machine. The Thomson-Houston machine has its armature described in the same chapter, but there is given no diagram of this machine either.

Chapter X. describes typical forms of field magnets, and compares the weights of copper and iron employed in the construction of the different patterns. The drawings seem to be a little out of scale in some of the figures on page 224, and it is not clear how for similar output and speed the author has arrived at the relation which scale measurement would give between Figs. 62 and 63. It is difficult to gather much from the comparison tables at pages 237 and 238, as neither temperature rise nor efficiency is the same for all. It will be noticed, however, that the lowest efficiency design has the lowest temperature, while as regards the two-pole type this is also the lightest, and as regards the four-pole type it is next to the lightest. Thus there are compensations, but, as the author points out, the selection of the particular design to be adopted depends upon quite a number of considerations, and no one design can be said to be best under all circumstances. In dealing with the stray field Mr. Kapp gets quite poetic, describing the machine as surrounded with "a kind of magnetic halo." We had thought there was little play for imagery in dynamo-designing, but "magnetic halo" is very fine, and we shall be sure to think of it in church when looking at the stained-glass saints.

The conditions for obtaining sparkless collection of the current and the relation which should exist between the magnet and armature fields are dealt with in Chapter XI., and form very interesting reading, while a chapter on the losses in dynamos from hysteresis and eddy currents follows. The examples of dynamos in Chapter XIV. are limited to one upright and one inverted machine of the single-magnet pattern, and a couple of sections of a special machine made at the Oerlikon Works. We cannot say that this portion of the work is very comprehensive, and the author might well have included a few more examples. But as regards alternators the same complaint cannot be sustained.

In Chapter XV. and onwards Mr. Kapp deals with alternators and transformers, and discusses fully the measurement of alternating E.M.F.'s, the influence of the shape of the coils and stray field on the curve of E.M.F.'s, how the strain on the insulation may vary according to the shape of this curve, and so on. But though the action of several machines described in preceding pages is influenced largely by self-induction, it is not until we reach page 375 that self-induction is explained or seriously referred to. Determining the self-induction in an alternator armature is not quite an easy matter. The current sent round it and the difference of potentials measured when it is out of the field, gives a result too low, while measured in the field, but while at rest, gives a result too high. Again, the latter depends on the exciting current through the field coils as well as on the position of the armature coils relatively to the poles. The influence of self-induction on the action of the alternator is described by the aid of clock-face diagrams, and the power given by an alternating current is also demonstrated geometrically. The time will soon come, however, when we shall cease to talk of self-induction as applied to dynamo armatures, expressing all that takes place in terms of "reactionary E.M.F.'s." Unfortunately there is as yet no solution which enables the reactionary effect to be predicted with certainty before a machine is built, and the designer, as a matter of practice, has to assume several different conditions, work out a calculation for each, and then take the mean of them. The effect of armature reaction (self-induction) as influencing the condition of stability for parallel working in central-station work is dealt with fully in Chapter XVI.—the results being very neatly summarised on page 434.

In Chapter XVII. we come to transformers, and the points to be kept in mind in designing being referred to, attention is called to the fact that the best design for any given purpose must always be a sort of compromise between a number of contradictory conditions. The behaviour of transformers under different circumstances is treated geometrically by clock-face diagrams. These in Mr. Kapp's hands are like the bow of Ulysses, which none other than he could handle with such effect. A chapter describing some of the best-known alternators concludes a book which should be in the hands of every student and every electrical engineer.

W. B. E.

ON LIGHT AND OTHER HIGH-FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

(Continued from page 610.)

In the diagrammatical sketch, Fig. 1, which has been already referred to, the cases which are most likely to be met with in practice are illustrated. One has at his disposal either direct or alternating currents from a supply station. It is convenient for an experimenter in an isolated laboratory to employ a machine, G, such as illustrated, capable of giving both kinds of currents. In such case it is also preferable to use a machine with multiple circuits, as in many experiments it is useful and convenient to have at one's disposal currents of different phases. In the sketch, D represents the direct, and A the alternating circuit. In each of these three branch circuits are shown, all of which are provided with double lines switches, *s s s s s s*. Consider first the direct-current conversion—I*a* represents the simplest case. If the E.M.F. of the generator is sufficient to break through a small air-space, at least when the latter is warmed or otherwise rendered poorly insulating, there is no difficulty in maintaining a vibration with fair economy by judicious adjustment of the capacity, self-induction, and resistance of the circuit, L, containing the devices, *l l m*. The magnet, N S, can be in this case advantageously combined with the air-space. The discharger, *d d*, with the magnet may be placed either way, as indicated by the full or by the dotted lines. The circuit, I*a*, with the connections and devices is supposed to possess dimensions such as are suitable for the maintenance of a vibration. But usually the E.M.F. on the circuit or branch, I*a*, will be something like 100 volts or so, and in this case it is not sufficient to break through the gap. Many different means may be used to remedy this by raising the E.M.F. across the gap. The simplest is probably to insert a large self-induction coil in series with the circuit L. When the arc is established, as by the discharger illustrated in Fig. 2, the magnet blows the arc out the instant it is formed. Now the extra current of the break, being of high E.M.F., breaks through the gap, and a path of low resistance for the dynamo current being again provided, there is a sudden rush of the current from the dynamo upon the weakening or subsidence of the extra current. This process is repeated in rapid succession, and in this manner I have maintained oscillation with as low as 50 volts, or even less, across the gap. But conversion on this plan is not to be recommended on account of the too heavy currents through the gap and consequent heating of the electrodes; besides, the frequencies obtained in this way are low, owing to the high self-induction necessarily associated with the circuit. It is very desirable to have the E.M.F. as high as possible; first, in order to increase the economy of the conversion, and secondly, to obtain high frequencies. The difference of potential in this electric oscillation is, of course, the equivalent of the stretching force in the mechanical vibration of the spring. To obtain very rapid vibration in a circuit of some inertia a great stretching force or difference of potential is necessary. Incidentally when the E.M.F. is very great, the condenser which is usually employed in connection with the circuit need have but a small capacity, and many other advantages are gained. With a view of raising the E.M.F. to a many times greater value than obtainable from ordinary distribution circuits, a rotating transformer, *g*, is used, as indicated in Fig. 2*a*, or else a separate high-potential machine is driven by means of a motor operated from the generator, G. The latter plan is, in fact, preferable, as changes are easier made. The connections from the high-tension winding are quite similar to those in branch 1*a*, with the exception that a condenser, C, which should be adjustable, is connected to the high-tension circuit. Usually, also, an adjustable self-induction coil in series with the circuit has been employed in these experiments. When the tension of the currents is very high the magnet ordinarily used in connection with the discharger is of comparatively small value, as it is quite easy to adjust the dimensions of the circuit so that oscillation is maintained. The employment of a steady E.M.F. in the high-frequency conversion affords some advantages over the employment of alternating E.M.F., as the adjustments are much simpler and the action can be easier controlled. But unfortunately one is limited by the obtainable potential difference. The windings also break down easily in consequence of the sparks which form between the sections of the armature or commutator when a vigorous oscillation takes place. Besides, these transformers are expensive to build. It has been found by experience that it is best to follow the plan illustrated in Fig. 3*a*. In this arrangement a rotating transformer, *g*, is employed to convert the low-tension direct currents into low-frequency alternating currents, preferably also of small tension. The tension of the currents is then raised in a stationary transformer, T. The secondary, S, of this transformer is connected to an adjustable condenser, C, which discharges through the gap or discharger, *d d*, placed in either of the ways indicated, through the primary, P, of a disruptive discharge coil, the high-frequency currents being obtained from the secondary, S, of this coil, as described on previous occasions. This will undoubtedly be found the cheapest and most convenient way of converting direct currents.

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* A lecture delivered before the Franklin Institute, at Philadelphia, February 24, 1893; and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

The three branches of the circuit, A, represent the usual cases met in practice when alternating currents are converted. In Fig. 1*b* a condenser, C, generally of large capacity, is connected to the circuit, L, containing the devices, *l l*, *m m*. The devices, *m m*, are supposed to be of high self-induction so as to bring the frequency of the circuit more or less to that of the dynamo. In this instance the discharger, *d d*, should best have a number of makes and breaks per second equal to twice the frequency of the dynamo. If not so, then it should have at least a number equal to a multiple or even fraction of the dynamo frequency. It should be observed, referring to Fig. 1*b*, that the conversion to a high potential is also effected when the discharger, *d d*, which is shown in the sketch, is omitted. But the effects which are produced by currents which rise instantly to high values, as in a disruptive discharge, are entirely different from those produced by dynamo currents which rise and fall harmonically. So, for instance, there might be in a given case a number of makes and breaks at *d d* equal to just twice the frequency of the dynamo, or in other words, there may be the same number of fundamental oscillations as would be produced without the discharge gap, and there might even not be any quicker superimposed vibration; yet the differences of potential at the various points of the circuit, the impedance and other phenomena, dependent upon the rate of change, will bear no similarity in the two cases. Thus, when working with currents discharging disruptively, the element chiefly to be considered is not the frequency, as a student might be apt to believe, but the rate of change per unit of time. With low frequencies in a certain measure the same effects may be obtained as with high frequencies, provided the rate of change is sufficiently great. So if a low-frequency current is raised to a potential of, say, 75,000 volts and the high-tension current passed through a series of high-resistance lamp filaments, the importance of the rarefied gas surrounding the filament is clearly noted, as will be seen later; or, if a low-frequency current of several thousand amperes is passed through a metal bar, striking phenomena of impedance are observed, just as with currents of high frequencies. But it is, of course, evident that with low-frequency currents it is impossible to obtain such rates of change per unit of time as with high frequencies, hence the effects produced by the latter are much more prominent. It was deemed advisable to make the preceding remarks, inasmuch as many more recently described effects have been unwittingly identified with high frequencies. Frequency alone, in reality, does does not mean anything, except when an undisturbed harmonic oscillation is considered.

In the branch, 3*b*, a similar disposition as in 1*b* is illustrated, with the difference that the currents discharging through the gap, *d d*, are used to induce currents in the secondary, S, of a transformer, T. In such case the secondary should be provided with an adjustable condenser for the purpose of tuning it to the primary.

Fig. 2*b* illustrates a plan of alternate-current high-frequency conversion which is most frequently used and which is found to be most convenient. This plan has been dwelt upon in detail on previous occasions and need not be described here.

Some of these results were obtained by the use of a high-frequency alternator. A description of such machines will be found in my original paper before the American Institute of Electrical Engineers, and in periodicals of that period, notably in the *Electrical Engineer* of March 18, 1891. I will now proceed with the *experiments.*

On Phenomena Produced by Electrostatic Force.

The first class of effects I intend to show you are effects produced by electrostatic force. It is the force which governs the motion of the atoms, which causes them to colide and develop the life-sustaining energy of heat and light, and which causes them to aggregate in an infinite variety of ways, according to Nature's fanciful designs, and to form all these wondrous structures we perceive around us. It is, in fact, if our present views be true, the most important force for us to consider in nature. As the term electrostatic might imply a steady electric condition, it should be remarked that in these experiments the force is not constant, but varies at a rate which may be considered moderate—about one million times a second, or thereabouts. This enables me to produce many effects which are not produceable with an unvarying force.

When two conducting bodies are insulated and electrified, we say that an electrostatic force is acting between them. This force manifests itself in attractions, repulsions, and stresses in the bodies, and space or medium without. So great may be the strain exerted in the air, or whatever separates the two conducting bodies, that it may break down, and we observe sparks or bundles of light, or streamers, as they are called. These streamers form abundantly when the force through the air is rapidly varying. I will illustrate this action of electrostatic force in a novel experiment, in which I will employ the induction coil before referred to. The coil is contained in a trough filled with oil, and placed under the table. The two ends of the secondary wire pass through the two thick columns of hard rubber, which protrude to some height above the table. It is necessary to insulate the ends or terminals of the secondary heavily with hard rubber, because even dry wood is by far too poor an insulator for these currents of enormous potential differences. On one of the terminals of the coil I have placed a large sphere of sheet brass, which is connected to a larger insulated brass plate, in order to enable me to perform the experiment under conditions which, as you will see, are more suitable for this experiment. I now set the coil to work, and approach the free terminal with a metallic object held in my hand—this simply to avoid burns. As I approach the metallic object to a distance of eight or ten inches, a torrent of furious sparks breaks forth from the end of the secondary wire, which passes through the rubber column. The sparks cease when the metal in my hand touches the wire. My arm is now traversed by a powerful electric current, vibrating at about the rate of one million times a second. All around me the electrostatic force makes itself felt, and the air molecules and particles of dust flying about are acted upon and are hammering violently against my body. So great is this agitation of the particles, that when the lights are turned out you may see streams of feeble light appear on some parts of my body. When such a streamer breaks out on any part of the body, it produces a sensation like the pricking of a needle. Were the potentials sufficiently high and the frequency of the vibration rather low, the skin would probably be ruptured under the tremendous strain, and the blood would rush out with great force in the form of fine spray or jet so thin as to be invisible just as oil will when placed on the positive terminal of a Holtz machine. This breaking through of the skin, though it may seem impossible at first, would perhaps occur, by reason of the tissues under the skin being incomparably better conducting. This, at least, appears plausible judging from some observations.

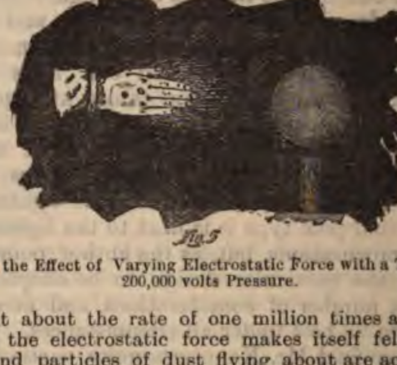


Fig 5

Illustrating the Effect of Varying Electrostatic Force with a Transformer 200,000 volts Pressure.

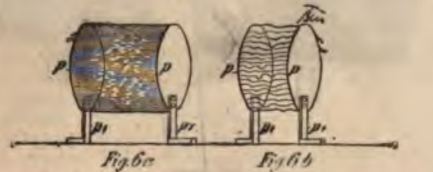
I can make these streams of light visible to all by touching with the metallic object one of the terminals as before, and approaching my free hand to the brass sphere, which is connected to the second terminal of the coil. As the hand is approached the air between it and the sphere, or in the immediate neighbourhood, is more violently agitated, and you see streams of light now break forth from my finger tips, and from the whole hand, Fig. 5. Were I to approach the hand closer, powerful sparks would jump from the brass sphere to my hand, which might be injurious. The streamers offer no particular inconvenience, except that in the ends of the finger tips a burning sensation is felt. They should not be confounded with those produced by an influence machine because in many respects they behave differently. I have attached the brass sphere and plate to one of the terminals in order to prevent the formation of visible streamers on that terminal, also in order to prevent sparks from jumping at a considerable distance. Besides, the attachment is favourable for the working of the coil.

The streams of light which you have observed issuing from my hand are due to a potential of about 200,000 volts, alternating in rather irregular intervals, something like a million times a second. A vibration of the same amplitude, but four times as fast, to maintain which over 3,000,000 volts would be required, would be more than sufficient to envelope my body in a complete sheet of flame.

But this flame would not burn me up; quite contrarily, the probability is that I would not be injured in the least. Yet a hundredth part of that energy, otherwise directed, would be amply sufficient to kill a person.

The amount of energy which may thus be passed into the body of a person depends on the frequency and potential of the currents, and by making both of these very great, a vast amount of energy may be passed into the body without causing any discomfort, except perhaps in the arm, which is traversed by a true conduction current. The reason why no pain in the body is felt, and no injurious effect noted, is that everywhere, if a current be imagined to flow through the body, the direction of its flow would be at right angles to the surface; hence the body of the experimenter offers an enormous section to the current, and the density is very small, with the exception of the arm perhaps, where the density may be considerable. But if only a small fraction of that energy would be applied in such a way that a current would traverse the body in the same manner as a low-frequency current, a shock would be received which might be fatal. A direct or low-frequency alternating current is fatal, I think, principally because its distribution through the body is not uniform, as it must divide itself in minute streamlets of great density, whereby some organs are vitally injured. That such a process occurs I have not the least doubt, though no evidence might apparently exist, or be found upon examination. The surest to injure and destroy life is a continuous current, but the most painful is an alternating current of very low frequency. The expression of these views, which are the result of long continued experiment and observation, both with steady and varying currents, is elicited by the interest which is at present taken in this subject, and by the manifestly erroneous ideas which are daily propounded in journals on this subject.

I may illustrate an effect of the electrostatic force by another striking experiment, but before, I must call your attention to one or two facts. I have said before that when the medium between two oppositely electrified bodies is strained beyond a certain limit it gives way and, stated in popular language, the opposite electric charges unite and neutralise each other. This breaking down of the medium occurs principally when the force acting between the bodies is steady, or varies at a moderate rate. Were the variation sufficiently rapid, such a destructive break would not occur, no matter how great the force, for all the energy would be spent in radiation, convection, and mechanical and chemical action. Thus the spark length, or greatest distance through which a spark will jump between the electrified bodies, is the smaller the greater the variation or time rate of change. But this rule may be taken to be true only in a general way, when comparing rates which are widely different.

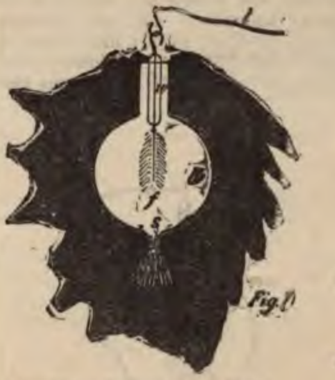


Illustrating the Effects of Rapidly-Varying and Steady Electrostatic Force.

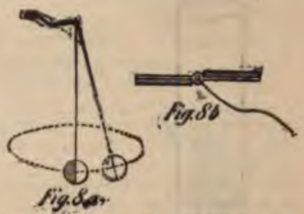
I will show you by an experiment the difference in the effect produced by a rapidly varying and a steady or moderately varying force. I have here two large circular brass plates, *p p* (Fig. 6*a* and Fig. 6*b*), supported on movable insulating stands on the table, connected to the ends of the secondary of a similar coil as the one used before. I place the plates 10in. or 12in. apart and set the coil to work. You see the whole space between the plates, nearly two cubic feet, filled with uniform light, Fig. 6*a*. This light is due to the streamers you have seen in the first experiment, which are now much more intense. I have already pointed out the importance of these streamers in commercial apparatus and their still greater importance in some purely scientific investigations. Often they are too weak to be visible, but they always exist, consuming energy and modifying the action of the apparatus. When intense, as they are at present, they produce ozone in great quantity, and also, as Prof. Crookes has pointed out, nitrous acid. So quick is the chemical action, that if a coil such as this one, is worked for a very long time it will make the atmosphere of a small room unbearable, for the eyes and throat are attacked. But when moderately produced, the streamers refresh the atmosphere wonderfully, like a thunderstorm, and exercise unquestionably a beneficial effect.

In this experiment the force acting between the plates changes in intensity and direction at a very rapid rate. I will now make the rate of change per unit time much smaller. This I effect by rendering the discharges through the primary of the induction coil less frequent, and also by diminishing the rapidity of the vibration in the secondary. The former result is conveniently secured by lowering the E.M.F. over the air gap in the primary circuit, the latter, by approaching the two brass plates to a distance of about three or four inches. When the coil is set to work you see no streamers or light between the plates, yet the medium between them is under a tremendous strain. I still further augment the strain by raising the E.M.F. in the primary circuit, and soon you see the air give way and the hall is illuminated by a shower of brilliant and noisy sparks, 6*b*. These sparks could be produced also with unvarying force; they have been for many years a familiar phenomenon, though they were usually obtained from entirely different apparatus. In describing these two phenomena so radically different in appearance, I have advisedly spoken of a "force" acting between the plates. It would be in accordance with accepted views to say, that there was an "alternating E.M.F." acting between the plates. This term is quite proper and applicable in all cases where there is evidence of at least a possibility of an essential inter-dependence of the electric state of the plates, or electric action in their neighbourhood. But if the plates were removed to an infinite distance, or if at a finite distance, there is no probability or necessity whatever for such dependence. I prefer to use the term "electrostatic force," and to say that such a force is acting around each plate or electrified insulated body in general. There is an inconvenience in using this expression, as the term incidentally means a steady electric condition; but a proper nomenclature will eventually settle this difficulty.

I now return to the experiment to which I have already alluded, and with which I desire to illustrate a striking effect produced by a rapidly varying electrostatic force. I attach to the end of the wire, *l* (Fig. 7), which is in connection with one of the terminals of the secondary of the induction coil, an exhausted bulb, *b*. This bulb contains a thin carbon filament, *f*, which is fastened to a platinum wire, *w*, sealed in the glass and leading outside of the bulb, where it connects to the wire *l*. The bulb may be exhausted to any degree attainable with ordinary apparatus. Just a moment before, you have witnessed the breaking down of the air between the charged brass plates. You know that a plate of glass, or any other insulating material, would break down in like manner. Had I therefore a metallic coating attached to the outside of the bulb, or placed near the same, and were this coating connected to the other terminal of the coil, you would be prepared to see the glass give way if the strain were sufficiently increased. Even were the coating not connected to the other terminal, but to an insulated plate, still, if you have followed recent developments, you would naturally expect a rupture of the glass.



Breaking a Bulb on Open Circuit



Mechanical Motions Produced by Varying Electrostatic Force in a Gaseous Medium.

But it will certainly surprise you to note that under the action of the varying electrostatic force, the glass gives way when all other bodies are removed from the bulb. In fact, all the surrounding bodies we perceive might be removed to an infinite distance without affecting the result in the slightest. When the coil is set to work, the glass is invariably broken through at the seal, or other narrow channel, and the vacuum is quickly impaired. Such a damaging break would not occur with a steady force, even if the same were many times greater. The break is due to the agitation of the molecules of the gas within the bulb, and outside of the same. This agitation, which is generally most violent in the narrow, pointed channel near the seal, causes a heating and rupture of the glass. This rupture would, however, not occur, not even with a varying force, if the medium filling the inside of the bulb, and that surrounding it, were perfectly homogeneous. The break occurs much quicker if the top of the bulb is drawn out into a fine fibre. In bulbs used with these coils, such narrow, pointed channels must therefore be avoided.

When a conducting body is immersed in air, or similar insulating medium, consisting of, or containing, small freely movable particles capable of being electrified, and when the electrification of the body is made to undergo a very rapid change—which is equivalent to saying that the electrostatic force acting around the body is varying in intensity—the small particles are attracted and repelled, and their violent impacts against the body may cause a mechanical motion of the latter. Phenomena of this kind are noteworthy, inasmuch as they have not been observed before with apparatus such as has been commonly in use. If a very light conducting sphere be suspended on an exceedingly fine wire, and charged to a steady potential, however high, the sphere will remain at rest. Even if the potential would be rapidly varying, provided that the small particles of matter, molecules or atoms, are evenly distributed, no motion of the sphere should result. But if one side of the conducting sphere is covered with a thick insulating layer, the impacts of the particles will cause the sphere to move about generally in irregular curves, Fig. 8*a*. In like manner, as I have shown on a previous occasion, a fan of metal sheet, Fig. 8*b*, covered partially with insulating material as indicated, and placed upon the terminal of the coil so as to turn freely in it, is spun around.

All these phenomena you have witnessed, and others, which will be shown later, are due to the presence of a medium like air, and would not occur in a continuous medium. The action of the air may be illustrated still better by the following experiment: take a glass tube, *t*, of about an inch in diameter, which ha platinum wire, *w*, sealed in the lower end, and to which is attached a thin lamp filament, *f*. I connect the wire with the terminal of the coil and set the coil to work. The platinum wire is now electrified positively and negatively in rapid succession, and the wire and air inside of the tube are rapidly heated by the impacts of the particles, which may be so violent as to render the filament incandescent. But if I pour oil in the tube, just as soon as the wire is covered with the oil, all action apparently ceases, and there is no marked evidence of heating. The reason of this is that the oil is a practically continuous medium. The displacements in such a continuous medium are, with these frequencies, to all appearance incomparably smaller than in air, hence the work performed in such a medium is insignificant. But oil would behave very differently with frequencies many times as great, for even though the displacements be small, if the frequency were much greater, considerable work might be performed in the oil.

The electrostatic attractions and repulsions between bodies of measurable dimensions are, of all the manifestations of this force, the first so-called electrical phenomena noted. But though they have been known to us for many centuries, the precise nature of the mechanism concerned in these actions is still unknown to us, and has not been even quite satisfactorily explained. What kind of mechanism must that be? We cannot help wondering when we observe two magnets attracting and repelling each other with a force of hundreds of pounds with apparently nothing between them. We have in our commercial dynamos magnets capable of sustaining in mid-air tons of weight. But what are even these forces acting between magnets when compared with the tremendous attractions and repulsions produced by electrostatic force, to which there is apparently no limit as to intensity. In lightning discharges bodies are often charged to so high a potential that they are thrown away with inconceivable force and torn asunder or shattered into fragments. Still even such effects cannot compare with the attractions and repulsions which exist between charged molecules or atoms, and which are sufficient to project them with speeds of many kilometres a second, so that under their violent impact bodies are rendered highly incandescent and are volatilised. It is of special interest for the thinker who enquires into the nature of these forces to note, that whereas the actions between individual molecules or atoms occur seemingly under any condition, the attractions and repulsions of bodies of measurable dimensions imply a medium possessing insulating properties. So if air, either by being rarefied or heated, is rendered more or less conducting, these actions between two electrified bodies practically cease, while the actions between the individual atoms continue to manifest themselves.

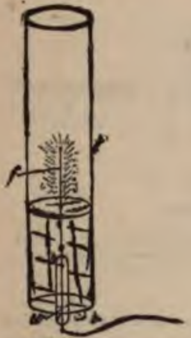


Fig. 9

Showing the Effect of the Air.

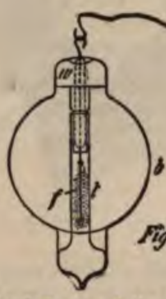


Fig. 10

Showing the Influence of the Conductivity of the Medium upon Electrostatic Actions through Measurable Distance.

An experiment may serve as an illustration and as a means of bringing out other features of interest. Some time ago I showed that a lamp filament or wire mounted in a bulb and connected to one of the terminals of a high-tension secondary coil is set spinning, the top of the filament generally describing a circle. This vibration was very energetic when the air in the bulb was at ordinary pressure, and became less energetic when the air in the bulb was strongly compressed. It ceased altogether when the air was exhausted, so as to become comparatively good conducting. I found at that time that no vibration took place when the bulb was very highly exhausted. But I conjectured that the vibration which I ascribed to the electrostatic action between the walls of the bulb and the filament should take place also in a highly-exhausted bulb. To test this under conditions which were more favourable, a bulb like the one in Fig. 10 was constructed. It comprised a globe, *b*, in the neck of which was sealed a platinum wire, *w*, carrying a thin lamp filament, *f*. In the lower part of the globe a tube, *t*, was sealed so as to surround the filament. The exhaustion was carried as far as it was practicable with the apparatus employed.

(To be continued.)

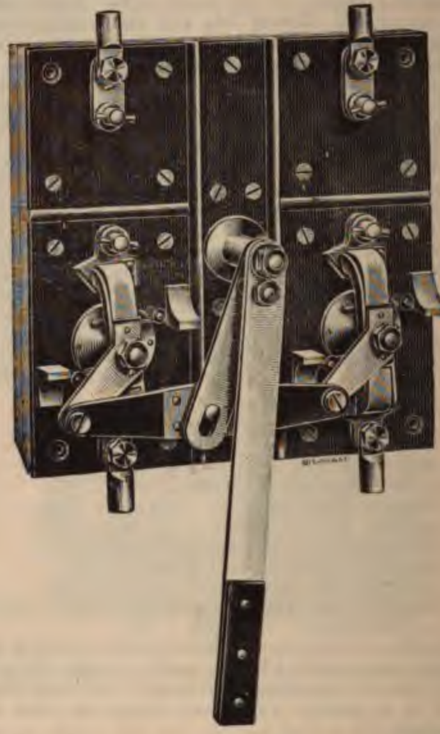
TRADE NOTES AND NOVELTIES.

"NEW DIAMOND" SWITCH.

A very powerful type of switch—so far as the pull-off arrangement is concerned—has been devised and put on the market by Messrs. Poole and White, Limited, under the name of the *"New Diamond"* switch. The contact-pieces and other such parts are of the regular diamond pattern; but for double-pole work—now becoming much more common than formerly—the usual bar of insulating material which joins the two switch arm levers has a strong pin fastened to its outer side so as to work loosely in a long slot at the end of a lever pivoted to the main switch-handle pillar in the centre of the board.

At the other end of this lever is a slot concentric with the pillar, so that another pin or bolt secured to the main switch lever may work loosely in it and allow the contact arms to break the circuit on the ordinary "loose-handle" principle. The main switch lever itself—of considerable length and strength—is pivoted also on the pillar in the centre of the board.

The annexed illustration will serve to show the design and construction of these switches. The switchboard or base itself is built up, as may be seen, of five separate pieces of enamelled slate, two of which carry the switches, and two others the main terminal blocks, so arranged that fuses can be inserted, whilst the centre piece supports the pillar and switch lever. The usual strong wood back is employed as a base upon which to fasten the slate pieces, strips of ebonite serving to insulate the latter still more.



These switches are built more especially for the heavy work incidental to central-station and similar usage, and will also convey large currents—varying, of course, with the size—up to, say, 1,000 amperes.

PHYSICAL SOCIETY.—June 9, 1893.

Prof. J. Perry, F.R.S., Vice-President, in the chair.

Prof. A. Jamieson, Prof. H. Stroud, and Mr. J. Wade were elected members of the society.

Mr. A. P. Trotter read a paper on "**A New Photometer.**" The author has modified his "illumination photometer," described *Proceedings* Institute Civil Engineers, vol. cx., paper No.2,619, so as to adapt it to the measurement of candle-power. The principle employed is to view a screen illuminated by one source through an aperture in a second screen illuminated by the other light, the aperture becoming invisible when the illuminations are equal. After using perforations of various patterns, a series of narrow slits cut in thin paper were found to give the best results. The plain screen is mounted behind the slotted one in a box sliding on the photometer bench, and they are arranged so that the light falls on them at equal angles. The screens are viewed from a distance of 6f. or 7ft. through an opening in the front of the box, cords being provided for producing the traversing motion. Two "sights" set respectively at the middle of the length of the plain screen, and on the lower edge of the front opening, serve to show when the middle of the band of equal illumination is vertically above the pointer on the carriage. The photometer is found to be particularly valuable when it is desired to determine the maximum power of a variable source. When lights of different colour are being compared, say a gas flame and an arc, one end of the screen shows blue strips on a yellow ground, and the other end yellow strips on a blue ground; at the centre the colours seem to blend. To facilitate the comparison of such lights, Mr. Crompton, who has been working at the subject simultaneously with the author, uses one screen tinted pale yellow and the other pale blue. Details of construction of the new photometer are given in the paper, and the accuracy obtainable when comparing the equal lights of about eight candles stated to be about 1 per cent.

Prof. S. P. Thompson, D.Sc., F.R.S., read "**Some Notes on Photometry.**" The first note relates to "The Use of Two Overlapping Screens as an Isophotal," and describes the evolution of the Thompson-Starling photometer. In this instrument a prismatic block with apex upwards rests crosswise on the photometer bench, and the inclined sides are respectively illuminated by the two sources to be compared. In testing differently-coloured lights, coloured stuffs were placed over the surfaces of the wedge. In some cases, notched and overlapping cards were used to form the overlapping surfaces; an inclination of about 70deg. between the two surfaces was found convenient. The second note refers to the "Periodic Principle of Photometry," and in it the author discusses the various methods which have been, or may be, used for producing small difference of decreasing amount between the two sides of a photometer screen. By employing a device of this kind much greater accuracy of adjustment is possible. In one form of vibration photometer worked out by the author, the paraffin blocks of a Jolly's photometer are mounted at one end of a spring, the other end being fixed to the carriage. The act of moving the carriage starts the blocks vibrating, thus producing the desired variations. In a third note the question of using "The Electric Arc as a Standard of Light" is dealt with. Since 1878 the positive crater has been used as a standard of whiteness, and last year both the author and Mr. Swinburne suggested that a given area of crater might be used as a standard of light. This proposal has since been carried out by M. Blondel. Since the intrinsic brilliancy of the crater is high, it necessitates very small apertures, or else the use of standards of large candle-power. Advantages of using powerful standards are pointed out in the paper. With a circular hole 1mm in diameter, a standard of about 55 candles could be obtained; with such a source, benches longer than usual would be preferable. At the end of the note, the errors which may be introduced by using as an arc standard a hole in a plate of sensible thickness, when viewed obliquely, are investigated, as well as those due to inaccuracy of setting the plane of a hole made in foil perpendicular to the photometer bench.

Major-General Festing, in opening the discussion on both papers, said reflection from the sides of the hole in a thick plate would tend to lessen the error calculated by Prof. Thompson. The ordinary impurities in carbon were not likely to alter the brilliancy of the crater. Captain Abney and himself had no reason to distrust its constancy. Both the vibrating photometer and Mr. Trotter's arrangement would be very useful. **Dr. Sumpner** said his photometric experience had been obtained with the Bunsen, Jolly, and Lummer-Brodhun types. With the two former, the inaccuracy arising from uncertainty of adjustment was about ½ per cent. Changes of about 0·4 per cent. (average) resulted from reversing the screens. The Lummer-Brodhun instrument (which he described) was better than either of the other two, the average error being about ¼ per cent. **Mr. Alex. Wright** thought scientific men gave too little attention to the question of light standards. Photometers could be relied on much more than the standard at present in use. The Methven screen was the most practical standard yet devised, but in his opinion no gaseous flame could be a real standard on account of the influence of the surrounding atmosphere. **Prof. Ayrton** saw difficulties in using long benches, as suggested by Dr. Thompson, on account of the serious atmospheric absorption which occurs with light from arcs. Decreasing the intensity by dispersion or otherwise was preferable. In some tests on incandescent lamps now being carried out at the Central Institution, a Bernstein lamp used as a standard was mounted on a spring and vibrated. **Mr. Medley** showed the vibrating standard referred to by Prof. Ayrton, and gave a series of numbers showing that with this device, in conjunction with the Lummer-Brodhun photometer, accuracies of about ⅕ per cent. were obtainable. **Mr. Swinburne** thought Mr. Trotter's arrangement was better than the wobbling photometer. As to the best length of bench, he was inclined to think the shorter the better, provided its dimensions were large compared with those of the standard light. He concurred with Mr. Wright in his remarks about the desirability of obtaining a better standard. Speaking of the arc as a standard, he said that only impurities less volatile than carbon would influence the brightness. An important factor was the emissivity of the carbon, which might not be constant. **Mr. Blakesley** thought the accuracy obtainable with Mr. Trotter's photometer had been underrated, and pointed out that by using quadrant-shaped screens intersecting orthogonally on the axis of the photometer instead of straight ones, the width of the neutral band could be greatly diminished. **Mr. Trotter**, referring to Dr. Thompson's paper, said he had found considerable difficulty in making pinholes suitable for arc standards. It was not an easy matter to accurately measure the hole when made. In photometric measurements he had found it very important to reverse his screens. Curved screens, as suggested by Mr. Blakesley, had been tried, but with little advantage. They also destroyed the approximate direct reading property of the photometer. The subject of changing the length of a bench and its effect on the gradient of illumination was discussed. With short benches one had to guard against a departure from the inverse-square law, due to appreciable size of the standard. Recent experiments had shown that the light given out by one square millimetre of crater surface differed considerably, from 70 candles.

A paper on "**The Magnetic Field Close to the Surface of a Wire Conveying an Electrical Current,**" by **Prof. G. M. Minchin, M.A.**, was taken as read. In this paper the author applies the solution he gave in March last for the conical angle subtended by a circle at any point in space to determine the magnetic potential at a point near the surface of a ring of wire of finite cross-section. The shapes of the lines of force near the surface, for several laws of current distribution across the section, have also been worked out.

COMPANIES' REPORTS.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

Directors: George Herring, Esq., chairman; the Right Hon. Lord Cloncurry; J. B. Braithwaite, jun., Esq.; B. H. Van Tromp, Esq.; Emile Garcke, Esq., managing director.

Report of the Directors to be submitted to the fourth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, London, E C. (Room No. 174), on Tuesday, June 27, 1893, at 3.30 p.m.

The Directors beg to submit the balance-sheet and profit and loss account for the year ended May 31, 1893. The profit and loss account shows a gross profit on the transactions of the year of £11,092. 15s. 4d, and after deducting all standing charges there remains a net balance available for distribution of £6,065. 16s. 5d. An interim dividend has already been paid on the ordinary shares for the first six months of the year at the rate of 20 per cent. per annum, and the Directors now recommend the payment of a further dividend upon the ordinary shares at the rate of 30 per cent. per annum for the past six months, and a dividend on the founders' shares of £30 per share. This will leave a balance of £65. 16s. 5d., which the Directors recommend should be carried forward in equal moieties on account of the ordinary shareholders and founders. Mr. George Herring has been elected chairman of the Company in succession to the late Duke of Marlborough, whose death the Directors deeply regret. The Directors who retire this year are Lord Cloncurry and Mr. Braithwaite, but being duly eligible, they offer themselves for re-election. The auditors, Messrs. Rait and Kearton, also retire, but offer themselves for re-election. It is proposed to make the dividends payable on July 1, 1893.

BALANCE-SHEET, MAY 31, 1893.		£	s.	d.
Capital authorised: £200,000 in 39,900 ordinary shares of £5 each; and 100 founders' shares of £5 each.				
Capital subscribed: 20,000 ordinary shares, 100 founders' shares.				
Capital called up:				
£1 per share on 20,000 ordinary		20,000	0	0
£5 ,, ,, 100 founders'		500	0	0
		20,500	0	0
Reserve fund founders' shares		10,133	5	4
Reserve fund ordinary shares		10,133	5	5
Loan account		20,000	0	0
Sundry creditors		3,094	11	6
Unclaimed dividends		5	18	4
Profit and loss account—				
Balance from 1892	£137 12 10			
Surplus of net profits for year ended May 31, 1893, after payment of interim dividend, Dec. 15, 1892, at the rate of 20 per cent. per annum for the six months	5,928 3 7			
		6,065	16	5
		£69,932	17	0

NOTE.—There is a contingent liability in respect of calls that may become due on securities held by the Company.

		£	s.	d.
Investments at cost		41,469	19	9
Loan against security		14,378	14	2
Sundry debtors		1,356	1	1
Cash on current account at bankers	£2,588 18 4			
,, dividend account	5 18 4			
		2,594	16	8
Founders' reserve fund, amount invested		10,133	5	4
		£69,932	17	0

PROFIT AND LOSS ACCOUNT FOR YEAR ENDED MAY 31, 1893.

	£	s.	d.
General charges, including Directors' fees, and additional remuneration as per articles of association, salary managing director, general expenses, legal charges, advertising, printing, and auditors' fees, etc.	3,164	11	10
Interim dividend paid Dec. 15, 1892, at the rate of 20 per cent. per annum for the six months	1,999	19	11
Balance, being surplus net profit for the year after paying 10 per cent. dividend to the ordinary shareholders as above	5,928	3	7
	£11,092	15	4

	£	s.	d.
Interest, dividends, commissions, and sundry profits	11,092	15	4
	£11,092	15	

BUSINESS NOTES.

Southend Pier.—Messrs. Crompton have doubled the plant at Southend Pier tramway, and there are now three cars running regularly for the summer season.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,867.

Situations Open.—The *Electrical Age* (World-building, New York) publishes a page of situations open in the States, from wheelwrights to superintending electrical engineers.

Coal for St. Pancras.—The Electricity Committee of the Vestry of St. Pancras are inviting tenders for the supply of Welsh steam coal, suitable for electric works, colliery and seam to be stated, for 12 months from July 1st, 1893. Average about 50 tons per week.

City and South London Railway Company.—The receipts for the week ending June 18 were £782, against £771 for the same period last year, or an increase of £11. The total receipts for 1893 show an increase of £1,649 over those for the corresponding period of 1892.

Central London Railroad.—The capital of the Central London Railway Company, formed to construct an electric underground railway from Liverpool-street to Shepherd's Bush, will be offered for public subscription, we are told, by the Exploration Company in a fortnight's time.

Aberdeen Co-operative Stores.—The secretary of the Northern Co-operative Company has received a requisition from 21 shareholders asking him to call a special meeting of the shareholders to consider the resolution of the directors to light the central premises in Loch-street and Gallowgate with electricity.

Howrah (India).—At the meeting of the Municipal Commissioners of Howrah (India), in May, a resolution was unanimously adopted sanctioning the introduction of electric lamps into all the principal streets and thoroughfares of Howrah of a tentative measure for four months, and allowing Messrs. Martin and Co. 55 reals per lamp.

Morecambe.—At the monthly meeting of the Morecambe Local Board a complaint was made by a deputation of householders in the vicinity of the electric light and power company's generating station of nuisances arising from noise, dangerous explosions, and noxious smells. The medical officer and surveyor were instructed to investigate the same and report to the Board.

Maintenance.—The average rates for existing contracts taken by the Electrical Power Storage Company for maintenance of accumulators is under 10 per cent. per annum of first cost. The company is prepared to consider proposals for maintenance under all possible conditions. The handsome catalogue of E.P.S. cells issued by the company should be in the office of every electrical engineer.

Aberdeen.—The Town Council of Aberdeen are prepared to receive applications for the appointment of electrical engineer. Applicants must have a thorough mechanical training and experience in station work. The salary will be £200 per annum, and the person appointed will be required to devote his whole time to the duties of the appointment. Applications are to be sent in by next Friday, the 30th inst.

Cost of the Electric Light.—"Mr. Preece," writes a Bradford correspondent of the *Birmingham Daily Post*, "is in error in stating that at Bradford the electric light is supplied at nearly the cost of gas. The fact is that it is quite the reverse. Gas is supplied at 2s. 3d. per 1,000 cubic feet, and the cost of the electric light, candle-power for candle-power, is, roughly, 4s. 6d. per 1,000, or just double the cost of gas."

Canterbury.—The town clerk reported at the last meeting of the Canterbury City Council that he had had a letter from the Board of Trade, who proposed making considerable alterations with reference to the transfer with regard to the electric light, and asking him to appoint a day on which to attend, together with a representative of the Brush Company.

Douglas and Laxey Electric Railway.—This line, which is being pushed forward with a view to a section being opened before the close of the holiday season, will be on the overhead wire system. The electrical contractors are Messrs. Mather and Platt, of Manchester; and Mr. J. J. Walklate, of the South Staffordshire tramways, and who was identified with the construction of the Walsall electric tramways, has been appointed resident engineer.

Aberdeen Mechanical Society.—The annual syllabus of excursions and investigations of the Aberdeen Mechanical Society has just been issued. The following is the list of the excursions for the season: Saturday, June 17th, electric lighting plant, Palace Hotel; Saturday, July 29th, electric lighting plant, Royal Infirmary; Saturday, August 26th, Messrs. Harpers, Limited, Craiginches; Monday, September 25th, Harbour of Refuge Works, Peterhead.

Bank-Lighting.—The lighting of the Manchester and Salford Savings Bank has been entrusted to Messrs. Drake and Gorham. The number of lights to be installed will be about 130. A 6-h.p. "Otto" gas-engine is being put down to drive a five-unit dynamo, and a battery of D.P. accumulators is included, capable of supplying 60 16-c.p. lamps for nine hours or 95 for four hours. The private house in connection with the bank will be supplied with current from the same plant.

Wilcox's Oils.—"Oil and waste—so much" is a standing item in all engineering accounts. With good oil your machinery "runs smooth," and a good refiner will supply you with oil for all and various purposes—cylinder oil, dynamo oil, crank-chamber oil, gas-engine oil, oil for drilling and lubricating machinery of every description. For these and all other lubricants, lubricators, and oil filters, and such like, the catalogue of Messrs. W. H. Wilcox and Co., 34 and 36, Southwark-street, S.E., will give full information.

Mix and Genest.—The International Electric Company (depôt of Mix and Genest, Limited), of 34, Aldermanbury, E.C., in consequence of the rapid growth of the business, are removing to more commodious premises at 55, Redcross-street, Barbican, E.C., where they propose keeping a much larger stock of all manufactures. The electric light fittings department will be enlarged, a varied assortment will be kept of "Helios" arc lamps, "Phœnix" carbons, electroliers, brackets, switches, cut-outs, etc.; also incandescent lamps, after the expiry of the Edison patent in November next. An elaborate showroom, where their specialities will be displayed working, is being fitted up.

Huddersfield Mains.—The Huddersfield Electric Lighting Committee are prepared to receive tenders for the following materials and labour requisite for laying an electric supply main: For the supply of 3in. cast-iron spigot and socket pipes; cast-iron junction-boxes; lead; spun yarn; and concentric conductors, insulated with vulcanised indiarubber. Also for the labour in excavating the trench, laying and jointing the pipes, fixing and connecting the junction-boxes, and drawing in the cables. Those tendering may undertake the whole or any portion of the work. Specification and forms of tender may be obtained upon application to Mr. A. B. Mountain, borough electrical engineer, Gas-works-street, Huddersfield, to whom tenders must be sent not later than Saturday, the 1st day of July, endorsed "Electric Supply Mains."

Fire Bells for Bournemouth.—Messrs. Roger Dawson, Limited, having submitted to the Bournemouth Lighting Committee an offer to erect complete telephones to each fireman's house for their respective stations for the sum of £185, and to maintain the same for £21 per annum, the committee recommended, having regard to the small additional cost of the complete telephones over the each way call bells, and the great advantage that would be gained, that Messrs. Dawson's proposal be accepted, subject to a satisfactory schedule for extending or reducing the lines as may be necessary being obtained. They further recommended that the application to the Local Government Board for sanction to the borrowing of £3,200 to defray the cost of works necessary for distributing electricity, pending the grant of the license, be increased by the sum of £200 for the provision of telephonic communication for the firemen.

Scarborough.—At the meeting of the Scarborough Town Council last week the Sanitary and Lighting Committee's report stated that, on May 18, the Council considered and approved the recommendation of a meeting of the Electric Lighting Sub-Committee held on the 15th with reference to the laying down of the mains, together with a letter from the secretary of the company. The committee recommended that the town clerk be instructed to forward the tracings to Mr. Bernard Drake, the electrical engineer, and subject to his approval thereof, the proposed system of fuses, safety earthing devices, and transformer-boxes be approved. At the same meeting of the sub-committee, the draft deed of transfer of the undertaking from the Corporation to the Scarborough Electric Supply Company, Limited, as altered by the Board of Trade was read. The town clerk was instructed to return the draft to the Board of Trade and ask the reason why the Board have made certain alterations in the draft deed of transfer, and state to them that the Corporation think it desirable that these alterations should not be made therein. These suggestions were also approved.

Weston-super-Mare.—At a meeting of the Inspection Committee of the Weston-super-Mare Town Commissioners on the 12th inst., a letter was read from the Brush Electrical Engineering Company, Limited, stating that they understood the electric lighting question at Weston would shortly come up again for consideration, and they therefore wrote to say that if the Board were not disposed to entertain the proposal they put before them to negotiate for the transfer of their provisional order, but preferred to keep the power in their own hands, and to establish a central station on their own account, they would be prepared to submit, free of charge, a scheme and tender for the complete equipment of a station at Weston upon the system which, after a careful survey of the districts to be served, they determine upon as the one best suited for the requirements, and they would be prepared to send down one of their representatives to wait upon the Board at any time in order to discuss the matter further, and to afford any general or preliminary imformation that might be required. The committee recommended the clerk to reply that a committee of the Board would be prepared to receive the Brush Company's representative upon a suitable date to be agreed upon.

Wolverhampton Electrical Engineer.—The Wolverhampton Lighting Committee reported at the last Town Council meeting they had 66 applications for the post of electrical engineer, from which seven candidates were selected, this number being reduced to two—viz., S. W. Baynes, electrical engineer to the Bradford Corporation, and F. H. Lewis, electrical engineer to the Hull Corporation. The committee arrived at the following resolution unanimously: "That Mr. Francis Harman Lewis be appointed electrical engineer to the Corporation of Wolverhampton at a salary of £300 per annum (to commence upon his entering upon his duties), subject to his residing within the municipal borough of Wolverhampton, and devoting the whole of his time to the duties of the office, and not engaging in any other employment whatsoever, and subject also to the appointment being determined by one month's notice given on either side." The committee added that they have appointed Mr. A P. Brevitt, of this town, to prepare the plans and specifications of the necessary buildings in connection with the electric lighting scheme. Mr. Brevitt's remuneration is 5 per cent. on the amount of the building contract as carried out in accordance with his plans and specifications, and includes all services rendered either by himself or his clerks acting as clerk of the works. The report was received.

Fleetwood.—The state of the electric lighting question at Fleetwood is progressing, though but slowly, as may be seen from the following from the *Fleetwood Gazette*: "Although the question of gas *versus* electric light is still destined to take a back seat at Fleetwood, on account of other and more pressing engagements the local authorities are bound to fulfil, there is little doubt that after the Improvement Bill has been dealt with the proposal to light the town with electricity will be seriously taken in hand. Already the Commissioners are in possession of full information relating to schemes for lighting the town with electricity, and we understand that the deputation which recently went to the South of England were most favourably impressed with the superiority of the new illuminant over gas. Many persons would be looking forward to the report of the deputation, but that also has had to be postponed, together with the other monthly business of the Board, on account of the Bill demanding attention. Hopes were held out last year that the gas company would reduce the present high price, but they have not thought fit to do so, and it must be confessed the tradesmen and other large consumers of gas will be sure to seize the earliest opportunity of lighting their premises with the cheaper and more cleanly substitute. It is a moral certainty the price of gas will then be reduced, and with little or no persuasion."

The London and Lancashire Electric and General Engineering Company, Limited, the management of which we noted a short time ago was taken over by Mr. C. N. Russell, A.M.I.C.E., is now, we understand, very busy in all departments, and have recently completed installations of electric light for the New York Mutual Life Insurance Company, Holborn; Messrs. Higgs and Co., Islington; Lipton's, Croydon; and Bolton-mansions Hotel, Earl's Court. Among the contracts now in hand is a complete installation of electric light for the British Paper Company, Limited, who have placed the order with the company for fitting-up their Frogmore Mill at Hemel Hempstead, where both incandescent and arc lamps will be used—the latter for the purpose of colour testing, as the mills run night and day. Installations are also in hand for the Central Advance Discount Bank, 84, Charing Cross-road; Messrs. Rising and Ravenscroft's City offices, Leadenhall-street, E.C.; Messrs. Pryke and Palmer, Upper Thames-street; J. N. Pimms, Esq., C.C., Manor House, Staines; Dr. Stott, Southgate; also Messrs. Lipton's branches at Sheffield and Portsmouth. The company, who undertake general engineering work, are also well employed in that department, and have recently put down some new plant. Their premises, it may be mentioned, are those at one time occupied by the old Maxim-Weston Company at Kingsland-green, Dalston.

Fire at Morecambe Electric Lighting Station.—On Sunday morning a fire broke out at the generating station of the Morecambe Electric Light and Power Company, by which considerable damage was done. The premises were locked up at midnight on Saturday by three of the company's employés, who carefully examined the building before leaving, and found everything apparently quite safe. About an hour later a passer-by noticed flames issuing from the roof of the engine-room, and raised an alarm. It being known that a large gasometer was kept on adjoining premises for the storage of gas used for the driving of the machinery, great excitement was created amongst the residents and visitors in the locality, who ran out into the street in their night clothes, carrying their children to places of safety. In a quarter of an hour a number of the company's officials were on the scene and entered the burning building. The fire was confined to the upper portion of the premises, in the basement of which the gas-engines were kept for working the dynamos. Just as the building was entered a portion of the roof fell in, the burning mass setting fire to the internal woodwork. A workman named Gregson rushed through the flames to a cupboard where a hose was kept, and this was being got into use when the Local Board brigade arrived at 1.30. The fire was then quickly extinguished. Damage was done to the extent of £300, which is covered by insurance.

Birmingham.—It will be remembered that last autumn the Birmingham Electric Supply Company gave notice of their intention to apply for a provisional order extending their area of supply by the addition of Edgbaston and the jewellery district. The City Council, acting upon the advice of the General Purposes Committee, decided not to consent to the application until they had taken an opportunity of considering the general question of the desirability or otherwise of the Corporation itself undertaking the supply of electric lighting. Under these circumstances the company withdrew their application. It is anticipated that new notices will be given towards the end of the present month, and, in view of this, the subject has been occupying the earnest attention of the Electric Lighting Sub-Committee, to whom it was remitted by the General Purposes Committee of the Council. Reports have been obtained from the various electric lighting companies, and from corporations which have undertaken the supply, and very full information has been collected for the guidance of the Council. We understand, says the *Birmingham Daily Post*, that some members of the committee are very anxious that the Corporation should undertake the supply, and should initiate steps to acquire the area already occupied, but that others consider that the time is scarcely ripe for an enterprise of such magnitude. Meanwhile, negotiations are in progress with the directors of the Electric Supply Company, and the ultimate decision will largely depend upon whether they see their way to adopt certain conditions upon which the Corporation might consent to the extension of their district, and which would, it is believed, safeguard the public interests pending a further delay in the settlement of the larger question.

Bedford.—At the meeting of the Bedford Rural Sanitary Authority last week the Electric Light Sub-Committee presented the following report: "Your committee have to report that in response to their advertisement inviting tenders or applications from companies or firms willing to undertake and carry out the powers granted under the provisional order, they have received three replies, printed copies of which accompany this report. No. 1 is from Mr. F. H. Medhurst, of Cambridge, and contains two alternative propositions: (*a*) a proposition to transfer to himself, under certain conditions, the provisional order; (*b*) a proposition to erect for the sum of £24,000 a complete installation. No. 2 is an approximate estimate from Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne (the firm that erected the Cambridge installation), for laying down a plant here at a cost of £12,000, exclusive of buildings. Both the above are accompanied by plans showing the proposed area of lighting. No. 3 sets forth memoranda of terms upon which the Bedford Electric Light Company, Limited, is willing to undertake and carry out the said order. Your committee have carefully considered the foregoing applications, and are of opinion as to No. 1 that it would not be judicious to entrust a work of such importance to a private individual; as to No. 2, they consider that it does not comply with the terms of the advertisement. The only application that fully conforms to the terms of the advertisement is No. 3, that of the Bedford Electric Light Company, Limited, and, having special regard to clause 4, which appears to us to meet the wishes of the memorialists, it is, in our opinion, the only one that we can recommend the Authority to entertain." The Deputy-Mayor said the Mayor had written suggesting that the report should be considered by a special meeting, and this suggestion was adopted.

New Swindon Junior Engineering Society.—The first of the summer excursions of the G.W.R. Mechanics' Institution New Swindon Junior Engineering Society took place on Saturday, June 10, when, through the kindness of P. K. Stothert, Esq., and H. G. Massingham, Esq., the respective managing directors, a fair number of members journeyed to Bath to visit the engineering works of Messrs. Stothert and Pitt, Limited, and also the City of Bath Electric Lighting and Engineering Works. The first-named visit in the morning was rendered particularly interesting from the fact that one of the firm's well-known "Titan" cranes was approaching completion. This crane is constructed to lift 25 tons at 75ft. radius, and is designed in 30ft. lengths for shipment to Pernambuco, in Brazil. Two traversing cranes for Southampton Docks and Dover Harbour, with other cranes in course of construction, attracted attention. The extensive use of mechanical stokers in the boiler-house was noted, and photographs of cranes constructed by the firm, kindly produced by Mr. Pitt, were inspected. In the evening the party visited the electric lighting works, its number having been greatly augmented by members who had joined it in the afternoon. Eight Brush vertical compound engines are the motive power in this interesting station, four for the incandescent lighting installation, coupled with continuous ropes to Mordey alternators, and four for the arc lighting installation, coupled with link belting to Thomson-Houston machines. Half only of these machines are in demand at one time, and there being seven miles of mains and 40 miles of cable, the precaution in thus having duplicates seems necessary. The visitors were conducted over the works by the managing engineer, Mr. G. F. Metzger, whose kind and instructive explanation of the machinery and system they greatly appreciated. A meeting will be held shortly to discuss the information gained during these visits, when short papers will be read by Messrs. W. L. Holt and H. G. Cotsworth respectively.

Taunton.—At the Taunton Town Council meeting last week, the Electric Light Committee reported as follows: "Your committee report that Messrs. Laing, Wharton, and Down Construction Syndicate have sent in an account of Dr. Fleming's, amounting to £24. 14s., his charges for attending at the Board of Trade enquiry *re* the electric lighting license, with a request that the Town Council would pay such charge. After some correspondence on the subject they agreed to accept £10. 10s. towards Dr. Fleming's charges. The town clerk informed the committee that Dr. Fleming was brought to Taunton by Messrs. Laing, Wharton, and Down, but that he and Mr. Fleetwood Pritchard had consulted him while he was here, and had called him as a witness. The committee resolved not to recommend the Council to pay Dr. Fleming's charges or any part thereof. The Local Government Board have asked to be furnished with evidence of the approval of the Board of Trade to the system for the supply of electrical energy; the Board required detailed information as to the proposed system which has been prepared by Mr. Hunt and forwarded to the Board of Trade. The committee hope to receive their formal approval in the course of a few days, which will be at once forwarded to the Local Government Board. Alderman Chapman formally moved the adoption of the report, explaining that he was at variance with his colleagues on the committee with respect to the payment of Dr. Fleming's charges. He considered that the town clerk did engage Dr. Fleming as an expert, and he thought that action should be backed up by the Council paying the £10. 10s. agreed on. Councillor Sibley said he understood, and the committee did also, that Dr. Fleming was to come down as representing Messrs. Laing, Wharton, and Down. Alderman Van Trump moved an amendment that the sum of £10. 10s. be paid. Councillor Potter said that Messrs. Laing, Wharton, and Down never anticipated sending down Dr. Fleming on the second occasion at their own expense. The town clerk gave it as his opinion that the Council would have no case if the claim was made against them. The amendment was agreed to, and the rest of the report was adopted.

Bournemouth.—At the Bournemouth Town Council meeting last week the Lighting Committee recommended that the town clerk be instructed to take the necessary steps to obtain a license for generating and supplying electricity in an area to comprise the Central Gardens (as far as Cambridge-road), the Winter Gardens and Pavilion, the Pier, and the Municipal Offices, that the requirements of the Board of Trade rules be complied with, and that an order be made on the treasurer for payment of the required fee of £50. The surveyor is to prepare the necessary plans. Councillor Lawson moved to extend the resolution so as to obtain the option of lighting the whole of the borough with electricity. Alderman George seconded. Councillor Jenkins supported because this might be another lever to get some consideration from the gas and water company. Councillor Moore, in answer to Councillor Hankinson, said the Council had not sufficient generating power for the lighting mentioned in the recommendation. Extra power would be necessary. Councillor Dyke asked if there was sufficient generating power for the Council buildings. The surveyor thought it would not be advisable, because the current was so small. Councillor Stockley suggested that as the Upper Gardens were to be lighted by electricity, as far as Cambridge-road, and the current was to be taken on the north side of the square, it would be a very short distance to lead the current, from the corner near Mr. Hankinson's office, to the Council buildings. Councillor Smythe reminded the Council that the Board of Trade license was only for a certain time. They could not reasonably hope to get the work done in time, and therefore it would be waste of money to secure the wider order, and would prejudice them if they afterwards applied for a new order. The committee have under their consideration a loan of £3,200 for these works, and Councillor Moore said this sum was based upon a scheme for lighting the gardens and pier which was adopted by the Council some months ago. Councillor Hankinson wished to add the words "for public purposes" to the amendment, so as to make it clear they did not intend to supply private houses. This would disarm opposition. The amendment was carried.

Madras Electric Tramways.—The directors of the Madras Electric Tramways Company have decided (says the *Indian Engineer*), as already stated, to adopt the conduit system. In this they have had the advantage of the services of Mr. Parker, an experienced engineer, who has made a close study of the climatic and other conditions of Madras. The result is that a conduit system has been devised which, for a slight percentage over the sum required for the overhead system, will provide a mode of traction in every way superior to the latter system, especially in being less liable to what is known as "short-circuiting" and consequent damage and stoppage of the cars. The drawings of this system have been received by the chief engineer in Madras, and Mr. Faulconer is preparing his plans for the approval of the municipality and the local government. Mr. Parker's proposal includes a cast-iron frame, about 18in. to 20in. deep on the inside, and about 6in. thick; one of these is placed at intervals of 4ft.; the conductor is pendant from the top of the frame, and by an ingenious arrangement is brought into contact with the grooved trolley, which is in direct communication with the wheel motors. The conductor is so placed that it cannot be tampered with from the outside. Great solidity and completeness mark the arrangement. Should the conduit require to be opened—it may not require to be opened once in 20 years, says the designer—the removal of a few inches of surface macadam allows of an iron covering to be lifted in sections of 4ft. Square iron gratings at 8ft. intervals permit of the insulators being easily reached by the hand at any time. The conduit is made large enough to allow of lighting and additional power cables being placed within it, should these be found necessary. By the side of the conduit, between the rails, will be laid either a copper or steel wire conductor, connected at every 4ft. with the rails and with the iron casing of the conductor. The result will be absolute protection for telegraphs, telephones, and harbour defence wires, while, in the use which will be made of the return current, the saving of fuel will be considerable. A skilled electrical engineer and other officers will be sent out with the plant, so that Mr. Faulconer will have all the expert assistance he may require. One advantage of the conduit system is that the rails and the equipment will be laid simultaneously, and as soon as the engine-house and boilers are ready for working, the completed portions can be turned to account for conveyance of materials and workmen, and for other purposes. Mr. Parker is of opinion that the expectations held out by the directors as to the date of opening the southern sections—viz., (1) from the Custom House to the South Indian Railway Terminus, (2) from the Chintadripet Junction to Barber's Bridge, Triplicane, and (3) from Harris's Bridge, Mount-road, to Royapettah, will be realised. Drawings of the central power station will probably be received in Madras within a fortnight, and no time will be lost in commencing construction. Mr. Parker himself may visit Madras in December next to superintend the finishing of the southern *sections* and the first runs of the cars. It is understood that the directors have been able to place their contracts at such rates as accord with the statements and promises held out in the prospectus.

Electrical Exhibition at Derby.—An interesting exhibition of electrical appliances, electric light fittings, etc., was opened in the Co-operative Hall, Derby, last week. The proceedings were promoted by Messrs. S. Rowbottom and Co., electrical engineers, of Derby, and in addition to the articles mentioned, there were also on view some very interesting curiosities and inventions connected with electricity. The opening ceremony was undertaken by Mr. Councillor Butterworth, in the absence of the Mayor. Mr. Butterworth said the Mayor would have been only too gratified to have opened the exhibition, only he had been called to London. He then proceeded to refer to the remarkable progress made in the direction of converting electricity to the various purposes to which it is now devoted, and spoke of the wonders of the electric telegraph, the telephone, and the electric light. He said they were all delighted to know that this great power was not going to be made the subject of any monopoly in Derby, but that the Town Council had taken steps by which, in a month or two, they would be enabled to supply all demands for electric light within a certain area. This supply would be provided at the uniform charge of 6d. per Board of Trade unit. That afternoon he had paid a visit to the electric lighting station in Full-street, where they had just commenced the work of laying the mains, and by the middle of next month some portion of the town would probably be illuminated from the central installation. It was also anticipated that by next August the whole area to which he had referred would be lighted by electricity, so far as the streets were concerned. It was for the purpose of demonstrating how the power of electricity could be used and the various purposes it could be made to serve, that Messrs. Rowbottom and Co. had arranged that exhibition, which, he hoped, would prove a great success. Speaking of the manner in which water could be utilised as a motive power for creating electricity, Mr. Butterworth remarked that he believed that the time would come when the tidal waters on the sea shore would be conveyed inland, and made to perform an important work in midland towns. Mr. W. R. Roe proposed a hearty vote of thanks to Mr. Councillor Butterworth for the ceremony he had so efficiently performed. In doing so, he related some of his experiences of the electric light during his recent Canadian tour, and remarked that compared with America the mother country was 50 years behind the times in the matter of electricity. The motion was carried with applause. The company afterwards inspected the lighting and the various electrical novelties included in the collection. The room had been most charmingly decorated, and the innumerable electric fairy lamps suspended from all parts considerably enhanced the beauty of its appearance.

Sunderland.—At the last meeting of the Sunderland Town Council the Highways Committee submitted the report which they had received from Prof. Kennedy respecting electric lighting (a printed copy of which had been sent to each member of the Council), and recommended that the Council adopt the same, and that West Sunniside be included among the streets specified to be added to those named in Schedule 2. Further, that Prof. Kennedy be instructed to prepare detailed plans and estimates for the carrying out of the scheme. Alderman Bell remarked that already two provisional orders to provide electric light in Sunderland had been obtained by the Council, and when the last was obtained the Board of Trade urged that the Council, if they desired to keep out private companies, should apply themselves to carrying out the order. They had done so so far as the report of Prof. Kennedy was concerned. They had agreed to pay that gentleman £105 for making his survey of the borough, but if they desired to put the order in force they had agreed that he should receive 4 per cent. on the cost of carrying out the necessary work, and that the £105 should be included in that percentage. The order expired this month. As had been stated, they had allowed the water company and the gas company to establish a monopoly, but they desired to have the power of providing electric light in their own hands. It was proposed that they should extend the original area to include West Sunniside, and the estimated cost of carrying out the present design was £17,000, exclusive of any building or land, because it was proposed to use the land the Corporation had in Dunning-street for works, and that was double the area they would at first require. Provided they carried the light to St. Michael's Ward and across the water, that would entail an additional expense of £3,500. The machinery it was proposed to put down would be capable of generating one-third more than the light which it was estimated would be required. If one shop in every four of the area included took the electric light, 5,600 8-c.p. burners would be required, and under these circumstances their income would be equal to an expenditure of £21,000 at 5 per cent. There would be no loss to the Corporation even at the start, because they could borrow what money they required at 3 per cent. Mr. Harrison seconded the adoption of the recommendation. He emphasised the fact that the time for which the provisional order was granted expired shortly, and it was not within the province of the Council to delay the matter any further. Either they must decide to provide electric light themselves, or allow someone else to do so. If they were to avoid another monopoly of a public requirement they must put their hand to the plough and proceed with the work. Mr. Harrison characterised the estimate as a moderate one, when it only allowed for one shop in four taking a light. The electricity they would be able to generate would apply to other things in addition to lighting. It could supply motive power, and be utilised for cooking purposes also. Of electricity it might be said that its cheapness and utility would create a demand, and the greater the demand the cheaper would be the supply. He had no doubt the Council would reap a handsome profit if they decided to undertake the supply of the electric light. Alderman Robson hoped the report would be agreed to, but thought that gas should be used instead of steam power, because of the expense which would attach to keeping steam-boilers in good condition. Alderman Thompson thought that as there was no application from the outside to the Council to provide the electric light and as there was no complaint as to the quality of the light supplied by gas, the Council would not be justified in spending £21,000 in providing it. At any rate he would prefer to know what profit had accrued to corporations who had already taken in hand the supply of the electric light. Mr. Roche thought the Council would agree that it was highly desirable, looking at the probable future, the Corporation should take some steps to protect their position with regard to electric lighting. Enormous sums of money had been lost to corporations in the past simply because they had hesitated to step in and occupy the ground, and he thought they would be making a mistake if they did not now step in and occupy the position open to them. He hoped the committee would see their way to extend the supply of the light to the residential part of the town, because he thought that would be a most remunerative part of the business. Alderman Bell said Mr. Roche's suggestion should have the consideration of the committee. Mr. Bruce expressed himself in favour of the report. Alderman Swan also said he was in sympathy with the proposed measure, but thought the Council should have more time to consider it. He therefore proposed that the matter should be referred back to the committee. Alderman Thompson seconded the amendment, but the recommendation of the committee that the scheme be carried out was ultimately adopted, only two members voting against it.

Yarmouth—Government Enquiry.—On Monday afternoon, Frederick Herbert Tulloch, Esq., A.M.I.C.E., the inspector appointed to hold an enquiry into an application made by the Yarmouth Town Council to the Local Government Board for sanction to borrow £15,000 for purposes of electric lighting, attended at the Town Hall to hear and receive evidence on the question. The enquiry took place under the Public Health Act, 1878, and Electric Light Act, 1882. There was a good attendance of the public and those interested, amongst whom were Councillors A. Peaton, J. W. B. Johnson, R. Martins, E. Press, H. Ferrier, E. Durrant, H. Bly, the Mayor (C. H. Wiltshire), T. Goate, and Messrs. W. B. Cockrill (borough surveyor), Preece, jun. (electrical engineer to the Corporation), H. Watt (chairman of the Ratepayers' Association), H. Burrage (secretary), H. E. Howes, R. H. Hammond, H. Watt (Pyemont and Watt), H. J. C. Keymer, Captain Wright, S. Randell, T. Rogers, and G. C. Blake. Mr. Councillor Peaton acted as spokesman of the opponents to the application. The Town Clerk stated that in 1890 the Council obtained an Act of Parliament confirming the provisional order giving power to the Corporation to supply electric light to the borough. A period of two years was fixed for supplying a certain area. That period expired in August, 1892. In 1891 the Corporation appointed a committee to consider the subject. They visited other towns and made a report to the Council. On June 14, 1892, the Town Council, by a majority of 17 to 13, resolved that Messrs. Crompton and other electric supply companies be requested to submit estimates for lighting the town by electricity. These tenders were received, and considered and reported on to the Town Council. On November 8 they were referred to a committee of the whole Council for further report. The matter came before the Town Council on December 13, and by a majority of 20 to 14 it was resolved to proceed at once with the electric lighting of the town, and to apply to the Local Government Board for sanction for a loan of £15,000, to provide from 50 to 100 arc lamps for public lighting and 4,000 private lights. Application was duly made, and on March 14, 1893, the matter came before the Town Council on a report from the Electric Lighting Committee containing a series of questions which the Board above desired to have answered. The Council then by a majority of 25 to 13 decided against an amendment to refer the matter back to committee for the purpose of presenting a modified scheme. Mr. Preece said it was proposed to adopt the high-tension system, worked at a pressure of 2,000 volts. The estimate for proposed work was as follows: Buildings, £3,000; machinery, £8,000; mains, £3,000; and contingencies, £1,000—total, £15,000. Mr. Martins, Dr. Watts, Mr. J. W. B. Johnson, Mr. B. H. Press, Mr. H. J. C. Keymer, and Mr. J. H. Bly offered evidence in favour of the application. The application was opposed by Mr. Peaton in its present form. Those who opposed the scheme would not object to a modified scheme, but the present one was inopportune on account of the present heavy burdens upon the town, which was driving away local manufacturers. The scheme projected, he thought, would not turn out to be self-supporting. Mr. Thomas Goate, a guardian, said he was not in favour of the electric light being introduced into the town at the present time. That opinion was largely entertained by public men, an opinion which he gathered as proprietor of Cromwell Hotel. Mr. Wells said every improvement made for the advance of the borough had been opposed in the first instance. But when the thing had been done, all the townspeople seemed to like it. The only thing they did not seem to dislike was the jetty. Mr. G. T. Browne emphasised one or two of the objections which had been made for a loan. If a vote had been taken, two out of three electors would have voted against the application. This was his conviction after a canvass of a portion of the town. The promoters of the scheme had not named a dozen people who would take the light. Then again, the town was most heavily rated. The Town Clerk said Yarmouth had the lowest rates of any watering place in the kingdom. Mr. Browne replied that the rates were now 7s. 8d. in the pound. The Town Clerk said these rates consisted principally of poor rates. Captain Wright considered that the presence of electric arc lights upon the esplanade would greatly endanger the shipping upon their dangerous coast, because so many lights would be confusing and misleading. Mr. T. Rogers spoke on behalf of the workpeople, amongst whom a distribution of £4,000 in labour would be welcomed. He could get as many signatures in favour of the scheme as was affixed to the petition against it. Mr. Rogers advanced other reasons in favour of the scheme. Mr. James asserted that the great majority of the population was against the scheme, and further stated that the manufacturers were leaving the town on account of the heavy burdens in the shape of rates. The enquiry then ended, the inspector stating that he would report to the Local Government Board, who would communicate with the Town Council.

Mr. Preece's Views on Electric Progress.—The *Pall Mall Gazette* of the 15th inst. published an important statement by Mr. W. H. Preece, who is daily and hourly occupied with the practical application of electricity, both in the Post Office, of which he is chief engineer, besides being in connection with nearly every large electrical enterprise in the kingdom. He is, therefore, able to predict from the sure data of experience, as well as to give a bird's-eye view of the past achievements. Only by conversing with such a man can one at all form an accurate conception of the vast revolution, physical and mental, that electricity is about to make in the near future. Much has been written and said about the new State telephone system and the cable connecting Ireland and Scotland laid last month, but it is not generally known how very comprehensive is the scheme, fully thought out in all its details by Mr. Preece. The plans for its practical realisation lay hidden in the proposals published in May, 1892, by the then Postmaster General. And although it is widely known that electric light is continually becoming cheaper and coming into more general use, few are aware that in one instance it is already supplied at the price of gas, and that in the Savings Bank Department last year the Post Office practically got their electric light for nothing. Talking to a representative of the *Pall Mall Gazette*, Mr. Preece said: "The cost of electric lighting is being very greatly reduced, and the reduction will continue with its greater use. If the continuous supply of electrical energy could be maintained and paid for throughout the 24 hours, its cost to the public would be very much less than that of gas. There are great hopes that its use for motive power in small industries during the day and for electric lighting during the night, will speedily bring this about. In fact, at this present moment there is in Newcastle and Bradford very little difference between the price of gas and that of electricity. My views on this point were regarded in Manchester and Nottingham as too sanguine; in each of these cases, however, the Corporation supplies the gas, and its judgment might have been, unconsciously, somewhat prejudiced. I am convinced that wherever in any given town electric light is very largely and continuously used, its cost to the consumer will rapidly come down.' 'Can you tell me of any case in which electric light is already supplied at the same rate as gas?' asked our representative. 'I only know of one instance,' replied Mr. Preece, 'that is in the Smithfield markets. There the conditions exist that I have explained to you as necessary—a large number of consumers are supplied within a limited area, and the supply is continuous for several hours. This has been adopted as the basis of a commercial undertaking by a firm of electricians (Messrs Julius Sax) who have agreed to supply the traders at exactly the same rates as gas, and they will undoubtedly make it pay well. You see, the markets open at about three or four o'clock in the morning and remain open till nine or ten. We are going to light up the Post Office throughout with electric light; then we shall have it cheaper than gas. Last year the ratio was 22 to 18, or about 15 per cent. dearer than gas; but in the department where it was used the absences through sickness diminished two days per head in the year, which among 1,500 people means 3,000 days more work. And as the value of the services was equal to the cost of the light, we get our light for nothing." Mr. Preece was of opinion that corporations 'ought to be compelled to provide electric light. They are compelled,' he said, 'to provide pure air, but in providing gas they are providing poison.' 'Then do you think that even the dwellings of the poor should be lighted by electricity?' 'Decidedly,' answered Mr. Preece; 'I believe it to be the poor man's lamp of the future." The recent growth of electric lighting in London Mr. Preece described as "enormous," and named to our representative a large number of public institutions where it was either already in use or being fitted up. He holds, however, very strong views with regard to overhead wires. For the telegraph invaluable, for the telephone absolutely indispensable, in the case of electric light he condemns them altogether. "Nearly all the accidents in New York," said Mr. Preece, "that have created a prejudice against electric lighting have arisen from the use of overhead wires, and I invariably advocate the use of underground conductors because of their safety, efficiency, and economy in maintenance. In the case of telephony it is quite a different matter. Perfect telephony would be absolutely impossible for long circuits with underground wires. It would with our present knowledge be absolutely impossible, for instance, to speak between London and Birmingham through an underground circuit. I wish to give publicity to this fact, because if the road authorities oppose overhead wires, I fear we shall have to exclude some authorities from the system of telephony we have in view. If we are allowed to carry out our plans unfettered by restrictions, and if the companies will only improve their services, as we have done in the Post Office, then the telephonic service in England will be unrivalled in the world. For the dimensions of our islands enable us to do what would be impossible in greater countries like the United States of America, or even Germany. There is no difficulty whatever in speaking between any two places in the United Kingdom if we are allowed to erect our wires overhead. But if we are forced by foolish notions of æstheticism to put them underground, purity and freedom of speech will be sadly interfered with, however the wires may be insulated. The use of earth in any form is the great bugbear of telephony, and all the recent improvements have been directed to remove all earth disturbances from our wires. The success of the London-Paris telephone has taught us a great many useful lessons." There was much connected with the plans of the Post Office, and even the new telephone system, that, in view of the impending Government enquiry, Mr. Preece did not feel himself at liberty to discuss at present with a representative of the Press; but so much may be safely declared, that it is not, as stated in some of the papers, only a few chief centres that it is intended to connect by telephone. The telephone is destined largely to take the place of the telegraph, and the telegraph is to be greatly developed, especially for Press work. It is, we believe, still somewhat uncertain if the Government will acquire all the telephone trunk lines, but the concluding remarks of Mr. Preece will give some idea of the extent of the Post Office scheme. "We propose," said he, "to establish at Leeds, in the very centre of England, a telephone exchange, with which every chief town in the United Kingdom will be connected, so that it will be possible for any town to speak with any other. A man sitting at his desk in the city of London will be able to speak with his correspondent in Glasgow or Aberdeen. A shipbuilder at Belfast will be able to speak to his client in Southampton, while the invalid at Torquay will be able to consult his doctor in Newcastle by speech. It is intended that the work in the towns themselves shall be done principally by the telephone companies, but the Post Office itself will open exchanges where there are no companies. It would, perhaps, have been better if the whole service could have been under the management of one administration. But the Government found that there were great difficulties in buying up existing companies, and they have elected to adopt a compromise which will certainly benefit the public."

PROVISIONAL PATENTS, 1893.

JUNE 12.

11462. **Improvements in or relating to electrical conductors.** John Henry Holmes, Theodore Holmes, and James Basnett Atherton, 6, Lord-street, Liverpool.

11464. **Improved galvanic electric belt or bandage.** William Phillips Thompson, 6, Lord-street, Liverpool. (Heinrich Theodor Biermanns, Germany.) (Complete specification.)

11516. **Improvements in alternate-current dynamos.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (La Société l'Eclairage Electrique, France.)

11517. **Improvements in dynamo-electric machines.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (La Société l'Eclairage Electrique, France.)

11521. **Improvements in electric motors.** Philip Middleton Justice, 56, Chancery-lane, London. (The Clyde Electric Motor Company, United States.)

JUNE 13.

11557. **Automatic electric call recorder.** William James Chivers, 18, High-street, Sutton.

11567. **Electric lamp, gas, water, or motive force meter.** Paul Cadot and Albert Charron, 17, Harp-lane, Great Tower-street, London.

11578. **A new or improved method of electrically welding metals.** William Phillips Thomson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

11579. **A new or improved method of, and apparatus for, electrically heating or welding metal.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

11596. **Improvements in secondary or storage batteries.** William Muir, 115, Cannon-street, London.

11608. **Improvements in electrical heaters.** James Finney McElroy, 18, Buckingham-street, Strand, London. (Complete specification.)

11609. **Improvements in electric switches.** James Finney McElroy, 18, Buckingham-street, Strand, London. (Complete specification.)

11610. **Improvements in apparatus employed in the evolution and collection of hydrogen and oxygen gases by electrolysis.** Charles John Yarnold, 433, Strand, London.

11649. **Improvements in apparatus for facilitating telephonic inter-communication.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

JUNE 14.

11680. **Improvements in electric alarm apparatus for doors, windows, and the like.** Friedrich Sauer and Carl Hentzschel, 70, Market-street, Manchester. (Complete *specification.*

11716. **The "preventum" crank and wire, and electric pull out bell-pull.** Charles Parkes, 53, Woodchester-street, Harrow-road, London.

11717. **Improvements in coal-plates, covers for cellars, electric light boxes, and like purposes.** The Safety Tread Syndicate, Limited, Joseph Mason, and Jonathan Mason, 55, Chancery-lane, London.

11728. **Improvements in switches for electric currents.** Ernest Francis Moy, 433, Strand, London.

11729. **Improvements in coin-freed machines for administering electric currents.** Philipp Reiner, 433, Strand, London. (Complete specification.)

11749. **Improvements in heating liquids by electricity.** Arnold Beaumont Woakes, 53, Chancery-lane, London.

JUNE 15.

11759. **Improvements in or relating to electric bells.** Charles Turnbull, jun., 3, St. Nicholas-buildings, Newcastle-on-Tyne.

11801. **Improved means and appliances connected with securing electric light fittings.** Charles Newton Russell, 166, Fleet-street, London.

11819. **Improvements in electric railway trolleys.** Edward Henry Allen, 47, Lincoln's-inn-field, London. (Date applied for under Patents Act, 1883, Sec. 103, 16th November, 1892, being date of application in United States.) (Complete specification.)

JUNE 16.

11842. **Improvements connected with the insulation of electrical conductors.** Ernest Payne, Hatchlands, Cuckfield, Sussex.

11890. **Improvements relating to telephones.** Parnell Rabbidge, 6, Bream's-buildings, Chancery-lane, London.

JUNE 17.

11921. **Improvements in and relating to suspensory apparatus, designed more especially for electric and other hanging lamps, but adapted for suspending and regulating the height of suspension of other articles.** William Henry Johnson, 70, High-street, Southampton.

11973. **Improvements in apparatus for electrolysis of water.** Siemens Bros. and Co., Limited, and Eugen Friedrich August Obach, 28, Southampton-buildings, Chancery-lane, London.

11977. **Improvements in electrical search and signalling light apparatus.** Sherard Osborn Cowper-Coles, 28, Southampton-buildings, Chancery-lane, London.

11983. **Contact-plates or electrodes for forming and charging, or for alternately charging and discharging plates or elements to be used in voltaic batteries.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

10451. **Electric current transformers.** Lucas and others.
12087. **Electric heating devices.** Schindler-Jenny.
13542. **Cells for electrolysis, etc.** F. E. and A. S. Elmore.
13678. **Electric bell push and stop.** Webb.
13718. **Electric conduits.** Doulton and Morris.
13765. **Electro-dynamic machines.** Hutin and Leblanc.
13894. **Submarine telegraph cables.** Preece.
14360. **Electric bell.** Davis.
15170. **Electromagnetic alarm apparatus.** Hoffmann.
23057. **Electric light ceiling roses.** King and Mendham.

1893.

5771. **Electrical lighting.** Scharf.
6922. **Electrically heating crucibles, etc.** Mitchell.
7471. **Electric annunciators.** Wilder.
8320. **Electric cigar lighters.** Smith.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¾
— Pref.	—	2½
City of London	—	11⅝
— Pref.	—	12⅝
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5 3	6¼ 4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6⅝
National Telephone	5	5¼
St. James'	—	8¼
Swan United	3½	3¼
Westminster Electric	—	5¾

NOTES.

Polyphase Currents.—M. Hospitalier has just published a work on "Polyphase Alternate Currents," which is published in England by Alabaster, Gatehouse, and Co.

Society of Arts Medal.—The council of the Society of Arts have awarded the society's silver medal to Mr. Gisbert Kapp for his paper on "Some Economic Points in Connection with Electric Supply."

Electropathic Belts.—The last of the electropathic belt actions—that by the Medical Battery Company against the *Electrical Review*—has, on the application of the latter's solicitors, now been struck off the list. Our contemporary makes a very strong and able summing-up of the result of the exposure of this "hideous mockery."

Conversazione.—The Society of Arts conversazione takes place to-day (Friday) at the Imperial Institute. The reception will be held from 9 to 12 p.m. by Sir Richard Webster, Q.C., M.P., and the members of the council. The Scots Guards, the band of the Royal Artillery, and the Red Hungarian Band will give selections. The East and West Gardens will be specially illuminated.

The "Volta."—A vessel with a history is for sale in the shape of Mr. Reckenzaun's electric boat "Volta.' This boat was one of the first really successful launches driven by electricity, and, apart from its other trips, made its name by crossing from Dover to Calais by electricity—the only vessel which has accomplished that particular feat. It is now to be disposed of at Millwall, fitted with its motor and gear, but without batteries. A whole history of accumulator electric traction is in these lines.

Magnetism at Sea.—A young sailor, who is engaged on an important work on magnetism and the compass, finding active work at sea does not give him sufficient time to properly attend to the subject, advertises on the 22nd inst. in the *Daily News* for employment or agency which would give him reasonable remuneration, and, we suppose, time to suitably develop his *magnum opus*. It is certain a work of this kind by a competent man might be very acceptable to shipowners and my lords of the Admiralty.

Sims - Edison Torpedo.—The French Minister of Marine will shortly make experiments at one of the great military ports with the Sims-Edison torpedo. The torpedo has a range of over two miles, and goes at the speed of 20 knots an hour. It carries 5cwt. of dynamite, a charge ten times greater than that of the Whitehead torpedo. This can even be increased to half a ton. The effect of the explosion of this weight would be almost impossible to foresee, the smaller charge being sufficient to sink an ironclad.

Standard Cells.—Dr. St. Lindeck has an article on "Electric Researches at the Physical and Technical Institute of Charlottenburg" in *L'Electricien* (June 24), dealing with the Clark standard cell. The various tests after reduction to 15deg.C. showed 1·4377, 1·4387, 1·4385, 1·4378, 1·4375, 1·4374, or a mean of 1·4379 volt at 15deg. C. He gives the arrangements adopted for testing, and comes to the conclusion that in the Clark cell we have a standard whose exactitude is sufficient for all possible practical purposes.

The Proposed Protective Clause.—The following is the clause proposed to the Parliamentary Committee by the electric traction interests for insertion in Tramway Bills or provisional orders: "The company shall use metallic returns, and in working their system shall take such reasonable precautions as the Board of Trade may direct for preventing interference with any properly-constructed insulated metallic circuit of any railway or telephone company, and for preventing electrolytic action on gas or water pipes."

Milan.—The electric railway at Milan is being erected by the Italian Edison Company in the Via Vincenzo Monti. The cars will seat 18 inside and carry other 18 standing on the platforms. The electric motor is of 15 h.p. to 20 h.p. The current, carried by overhead trolley wires, will be generated by two 150-h.p. engines and dynamos. The conductor will manipulate two handles—a switch and a brake—at either end of car. The laying of the line will be finished at the end of August, and the cars will be running in September.

Telephone in Thunderstorms.—As was illustrated a few weeks ago at Leeds, it is dangerous to make use of the telephone in a storm of thunder and lightning. This week, the 34th Regiment of Artillery, in garrison at Metz, was executing some firing exercises in the polygon at Haguenau, and, as usual, sentinels had been placed in various directions to stop circulation within the dangerous zone. An artilleryman placed his ear against the receiver of the telephone, when a flash of lightning suddenly struck the wire and killed him.

Annular Parabolic Reflector.—A singular combination for reflectors for an electric lamp is described in *Cosmos* for 27th ult. A large parabolic reflector at the back reflects the back rays of an electric lamp. In the front are four or five portions of parabolic reflectors in annular rings. The result, says the inventor, is surprising, and indicates this as a useful arrangement for colliery, tramway, or other similar lamps. Sections and views are given of this new lamp. It is the invention of an Italian colonel, G. Bellati, and is made in large quantities by Carello Frati, of Turin.

Cable Relays.—The *Revue des Postes et Télégraphes* states that Paris communicates now regularly with Algiers direct on the Hughes telegraph, by the use of M. Willot's cable relays, of which mention has recently been made. In July last trials were made with success, but it was not thought possible to use the relays on the regular service. Now the service is carried on regularly from 11 a.m. to 6 p.m. every day, and works admirably at 105 to 115 revolutions. The distance between Paris and Algiers is 1,600 kilometres (1,000 miles), of which 900 kilometres is over submarine cable.

Utilisation of Small Water Powers.—M. Chédeville in *Electricité* gives some curves and calculations on the utilisation of small rivers, instancing the case of a small effluent of the Marne, which by not costly works can give 33ft. fall. The mean flow is 225 litres per second, and in winter it may only be 100 litres. To utilise the fall it may be done direct, or with storage cells; but the author gives figures to show with a dam 25 times the direct output can be achieved (2,300 16-c.p. lamps), or seven times that with cells for six hours in winter or two in summer. He thinks much might be done with these small water powers.

Primary Battery Competition.—*L'Elettricita* published last week a list of those who have entered for its primary battery competition. It will be remembered that a prize of 2,000 lire (£100) was offered for the best battery, to be patented and put in manufacture, the inventor to have 30 per cent. of the profits. Fourteen cells have been admitted, the first, a single-liquid cell without depolariser, has as motto, "$CaO + 2HCl = CaCl_2 + H_2O$." There are five cells single-liquid with solid depolariser, four with sal ammoniac, and one with potash or caustic soda; one with gaseous depolariser, four with a liquid containing depolariser, and three double-liquid cells. An ozone cell is admitted, and many inventors have sent descriptions, but have left too late the forwarding of a model of their cell.

Civil Engineers.—At the first meeting of the recently elected council of the Institution of Civil Engineers, the following reappointments were made: Mr. Hugh Lindsay Antrobus as treasurer, Dr. William Pole, F.R.S., as honorary secretary, and Mr. James Forrest as the secretary. The council consists of Mr. A. Giles, president; Sir Robert Rawlinson, K.C.B., Sir B. Baker, K.C.M.G., LL.D., F.R.S., Sir James N. Douglas, F.R.S., and Mr. J. Wolfe Barry, vice-presidents; Dr. William Anderson, F.R.S., Mr. Alex. R. Binnie, Sir Douglas Fox, Sir Charles Hartley, K.C.M.G., F.R.S.E., Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Prof. Alex. B. W. Kennedy, F.R.S., Sir Bradford Leslie, K.C.I.E., Mr. James Mansergh, Sir Guildford L. Molesworth, K.C.I.E., Mr. W. H. Preece, F.R.S., Sir Edward James Reed, K.C.B., F.R.S., M.P., Mr. William Shelford, Mr. F. W. Webb, and Mr. W. H. White, C.B., F.R.S.

Yorkshire College Mining Classes.—The mining classes under the tuition of Prof. Lupton at the Yorkshire College, and at the Barnsley and Derby centres of the Yorkshire and Derbyshire County Councils, recently made an excursion to the Birley Collieries of the Sheffield Coal Company, by the kind invitation of Mr. T. R. Gainsford. The party were met by Mr. Hargrave Walters, the manager of the collieries, and were conducted over the works and down the pit. Great interest was taken in the electrical apparatus, and in the numerous ingenious mechanical contrivances of Mr. Walters; also in the handsome and complete plant at the new pit, where the banking arrangements are of the latest and best kinds. Mr. Walters, whilst using electricity and compressed air for special purposes, makes chief use of the wire-rope system for transmission of power, and he gave the party a great deal of most valuable instruction.

Dynamos and Ships' Compasses.—At the present moment, when the world is face to face with one of the greatest horrors in modern times in the sinking of the battleship "Victoria," the following official note may have special interest: The Admiralty has directed that all ships fitted with 300 and 400 ampere dynamos are to be specially swung for the purpose of ascertaining the effect of the dynamos on the ships' compasses. The effect on all the compasses is to be specially noted, and a report forwarded to the Admiralty. The Lords of the Admiralty have directed that the minimum distance between dynamos and compasses is to be 60ft. in the case of a 300, and 70ft. in the case of a 400-ampere machine; and in the light of the experiments that are now to take place, it would be interesting to know the distances between the dynamos and compasses of three of her Majesty's ships that have recently been damaged by getting into positions at direct variance with the navigator's intentions.

Simultaneous Telegraphy and Telephony.—According to the *Elektrotechnischer Anzeiger*, M. Jules Demetzky, of Budapest, has constructed an apparatus enabling telephonic communication along a telegraph wire to take place while sending telegrams. This apparatus has been brought to sufficient perfection to allow experiments to be made, with the authorisation of the Hungarian Minister of Posts and Telegraphs, over the length of line between Budapest and Szegeddin. The tests seem to have been entirely successful. The apparatus is very simple, and can be introduced with the greatest facility on any telegraph line, which can be then employed for telephonic service. The simultaneous transmission of telegrams by the same wire does not interfere in the least with the use of the telephone, and the apparatus is stated to have the effect of causing all strange induction sounds to disappear. When employed for short distances, as on local exchange circuits, the apparatus "acts so strongly that conversation can be heard very distinctly, without receiving telephone, by several persons placed within the room."

Wooden Poles for Electrical Work.—England is still in the rural districts not what one would call very thickly populated, but the generations of inhabitants have apparently been there long enough to bring down the growth of woods and forests to a minimum; and the relative scarcity of wood and abundance of metals has as much as anything else caused the employment of so many iron or steel poles for telegraphic, telephonic, electric light, and electric tramway purposes. In the United States, however, the case is different, and cedar poles are obtainable in any quantity at something like half the price of iron ones. The great lumber interests in the Michigan backwoods are beginning to make a specialty of poles for electrical work, in sizes from 6in. to 8in. at the top, and 9in. to 11in. at the bottom. For traction purposes octagonal poles seem to be patronised, of a length equal to 28ft. over all, 6ft. at the base being coated with preservative ready for burying in the ground. The above-ground portion is planed, shaped off to a point at the top, and painted, so that the electric tramway contractor has his otherwise thorny road made smooth for him in this respect at least.

Communication with Lightships, Etc.—Mr. H. Benest writes calling attention to one portion of our report of the paper read before the Institution of Civil Engineers of Ireland by Mr. Jno. Rochford, which refers to a method of preventing the twisting or untwisting of cable taken on board a lightship as having been tried at a cost of £4,855, and the statement that the trial extended over two years. Mr. Benest points out that this idea originated with him several years ago, and was explained by him in a paper read before a meeting of the Balloon Society in March, 1891. Mr. Benest has communicated with Mr. Rochford, who has replied that the account we gave was incorrect. We are accustomed to having our reports questioned when third parties doubt the correctness of the author's words, as in this case. As a matter of fact, our report was from the official printed proof of the institution sent to us officially; hence, if it contained any statements incorrect, the statements were the author's, and not ours. We object strongly to be made the scapegoat for errors of this kind, and have no doubt that the paper when published in the *Transactions* of the society will have been corrected.

Society of Arts.—The report of the Society of Arts, adopted at the annual general meeting, is a long and interesting document, discussing, as it does, the work of the society during the year. In the first place it calls attention to the various papers read, among which, as our readers well know, were some exceedingly interesting papers on electrical matters by such authorities on their subjects as Prof. Forbes, Prof. Silvanus P Thompson, and Mr. Gisbert Kapp. Besides the ordinary papers, the society usually provides a course of Cantor lectures of the greatest value to electrical engineers upon some prominent electrical subjects. This year Dr. Fleming gave a course of four lectures on "Alternating Currents," which will be duly printed in the society's *Journal*, but it is well known that the society has taken great interest in the World's Fair at Chicago, and a large portion of the report deals with what has been done in this matter. There is no doubt that the Society of Arts is fulfilling an important function in our midst. It is pre-eminently an educational society, and its papers are almost always authoritative upon the subjects with which they deal. We trust its present great success will be long continued.

High Speed.—Locomotive No. 999 on the New York and Hudson Railway made a record run on May 9. The train was 28 minutes late at Rochester, and the distance, 69 miles, to Buffalo, was run in 68 minutes. One distance, five miles on the level, from Looneyville to Grimesville, was run in 3½ minutes, being at the rate of 86 miles an hour. But one mile on the level west of Grimesville was run in 35 seconds by the conductor's stopwatch—this was at the extraordinary speed of 102·8 miles an hour. The train consisted of four cars, weight of cars and passengers 362,000lb., of engine and tender 204,000lb. The cylinders were 19in. by 24in., and the driving wheels 86in., boiler pressure 190lb. We allude to this remarkable performance as the question of high speed as between steam-engines and electric motors is now being widely discussed. It is necessary to remember that the extra danger and the wear of heavy engines run at such speeds will necessarily preclude any attempt to make these speeds the common practice with the present build of road bed, cars, and locomotives. The record, however, is exceedingly interesting. The engine was designed by Mr. Wm. Buchanan, superintendent of motive power, who appends his name to the report of the run.

Telephone Meter.—The question has often been discussed as to the utility of having a meter which should indicate the length or number of conversations by telephone, and should thus allow the telephone companies to charge their subscribers according to the use of the line. Messrs. Mix and Genest, the well-known constructors of telephonic apparatus, of Berlin, have recently constructed an hour meter of this kind. It consists of a simple clock, whose pendulum or escapement is released when the telephone is taken from the hook, so that it goes only when conversation is being held. A special signal shows when the clock requires winding. If the clock runs down, the subscriber cannot make use of the telephone as the line contact is not made. The instrument is simple and may be useful. Its greatest defect, of course, is that it plays into that company's exchequer which takes the longest time in making connection through. But perhaps this can be overcome. It is well to remember that electric light, at first all taken on contract, is now all sold by meter. The question may certainly be asked, Why not telephonic communication by meter instead of by contract? "Let the busy pay for their business." What do the companies say?

Accumulator Tests.—The following tests are an extract from the results of the examinations of the accumulator batteries of the Union Bank, St. Gallen, by Prof. H. F. Weber, of Polytechnic Electrical Institute, Zurich: 1. The electric current used for charging the batteries was 698·97 ampere-hours; on being discharged the batteries gave 674·84 ampere-hours. Hence the effective current hours in relation to the total electric current hours is 96·5 per cent. 2. The electric energy required for charging was 94,770 watt-hours; on being discharged it delivered in the external circuit 78,080 watt-hours. The ratio of the effective energy to the total charging energy is therefore 82·4 per cent. Prof. Weber further reports: "As in accordance with my extensive experience well-constructed, carefully-served, and continually active accumulator batteries yield on discharge from 93 to 95 and 97 per cent. of the electric current used for charging, and 80 to 82 and 84 per cent. of the electric force used in charging, I consider that the E.P.S. accumulator batteries supplied to the Union Bank by Messrs. Gmur Bros., are now in the best possible condition and of very good working capabilities." These tests will have interest to all users of secondary cells.

Conversazione.—The annual conversazione of the Institution of Electrical Engineers was as successful and interesting as ever. Among the guests who accepted the invitation of the President (Mr. W. H. Preece, F.R.S.) were the following: Lord Kelvin, P.R.S., Sir George Berkley, K.C.M.G. (past-president I.C.E.), Mr. A. Giles (president I.C.E.), Mr. Edward Woods (past-president I.C.E.), Sir J. Danvers, Sir Bradford Leslie, K.C.I.E., Sir Albert Rollit, M.P., Sir C. A. Hartley, K.C.M.G., Sir John Puleston, Sir Frederick Bramwell, F.R.S., Sir David Salomons, Bart., Sir William Flower, Sir James Crichton Browne, M.D., F.R.S., Sir Owen Roberts, D.C.L., Earl Russell, Colonel Hayward, Sir J. Jennings, Sir B. Baker, K.C.M.G., General Webber, C.B., Colonel R. Thompson, General Young, Mr. H. W. Christmas (Consul-General for Servia), Dr. John Hopkinson, F.R.S., Dr. J. H. Gladstone, F.R.S., Dr. E. Frankland, F.R.S., Dr. W. H. Perkins, F.R.S., Captain Creak, R.N., Prof. George Forbes, F.R.S., Prof. W. G. Adams, F.R.S., Prof. D. E. Hughes, F.R.S. Prof. R. Meldola, F.R.S., Prof. Perry, F.R.S., Prof. S. P. Thompson, F.R.S.. Prof. A. W. B. Kennedy, F.R.S., Mr. J. W. Swan, Mr. A. Siemens, M.I.C.E., Mr. Crompton, M.I.C.E., Mr. C. E. Spagnoletti, M.I.C.E.

Lightning in a Private House.—During a destructive thunderstorm which broke over Huddersfield on the morning of Sunday, the 4th inst., the house of Mr. H. Kilner, of Kirkheaton, sustained considerable damage. Mr. Kilner states that just before eleven o'clock he heard a tremendous crash. The house was plunged into darkness, and he was struck on the head and shoulders by flying furniture, and his neck was cut and seared. It seemed as if a bombshell had exploded in the middle of the floor. He was stunned for a moment; but, groping round for the children, of whom there were three, he made for the door, but found it blocked by fallen boards, which had come from the passage partition. When Mrs. Kilner and the children got out of the house it was found that one of them was slightly scorched, but otherwise uninjured. Every picture was stripped off the wall and smashed to atoms. The floor flags were lifted up and damaged in several places, and the cupboard doors, the mirrored sideboard, and the chairs were broken. The house will have to be completely refurnished. The lightning also struck the house occupied by Mr. G. Kilner, Mr. H. Kilner's father, and an eye-witness states that as he was going up the road in the direction of the houses he felt himself lifted off his feet, and nearly deafened by the crash. He ran forward, and saw Mrs. George Kilner come out of the house, her face covered with soot. In Mr. G. Kilner's house there was a small electric bell, but the bell had vanished along with the wire, while the button was found a considerable distance from the house. Some of the back windows of the houses were blown 30 yards or more, and much damage to furniture was also done at the house of Mr. G. Kilner.

Over-Compounding.—Most continuous-current installations are now made for constant pressure; therefore compound dynamos are the rule. Electrical engineers build machines of certain types that maintain a practically constant voltage at all loads, provided the speed remains the same. M. P. Simon, in *L'Electricien*, thinks this standpoint is not the right one, and that all machines should be over-compounded. Beyond the question of stray lines, which always exist, there is the engine which drives the dynamo. Now, it is impossible for this to maintain exactitude of speed. We constantly find electrical engineers ask the engine-builders to provide engines to run at equal speed throughout the whole scale of load with no greater variation than 1 or 2 per cent. between maximum and no load, in order to obtain constancy of pressure in commercial dynamos. But while it is very easy to over-compound a dynamo, it is not so easy to preserve the same speed in an engine. If we examine how a governor acts, we shall find, indeed, that it cannot act until a certain change of speed has taken place. There is, therefore, a certain lag of the governor. Great delicacy of action is obtained, but we cannot avoid this fault altogether. If we suppose, moreover, that the dynamo is driven by ropes or belting, this variation is still more important. This fact would lead one to enquire whether it is desirable to have dynamos exactly compounded, or if they would not be better over-compounded; and, if so, how much? For large machines this would require special consideration for each case, but for ordinary sizes a slight excess of series excitation—M. Simon thinks 5 per cent.—would be advantageous. He suggests that dynamo-builders should add to their tests the words: "All our compound machines are over-compounded 5 per cent. to guard against all causes that may tend to lower the voltage as the load increases." This arrangement, he thinks, will avoid many awkward surprises to small users without increasing the price of dynamos.

The Telephone in 1892.—The *Journal Télégraphique*, the official organ of the Bureau Internationale des Administrations Télégraphiques at Berne, gives particulars of the constant progress of the telephone throughout the world. In spite of the difficulties presented by the gathering of regular statistics, by reason of the too frequent collapse of private companies, the *Journal Télégraphique* has been able to obtain particulars from thirteen of the most important countries, comprising a civilised total population of 200 millions. These countries possessed at the end of 1892, 1,901 localities provided with telephone exchanges; the lines represented 731,680 subscribers, the number of stations amounted to 363,512, and the number of urban and inter-urban conversations to the grand total of 800,754,500. According to these figures, there will be a subscriber to about every 600 inhabitants, and an exchange to every 100,000. The general average of conversations a day is seven, a little less than that of the American Bell Telephone Company. In France, at the end of 1891 there were 112 exchanges, 46 were in course of construction, and the subscribers were 18,191. The total receipts for the year were 5,574,592f., most of which came from Paris, which has 10,000 subscribers. During 1892, 108 other exchanges were established, making the total authorised 266. There have been 226 new exchanges authorised, or 75 per annum, since the State took over the telephone. This result would show that France will soon be equal to the best-equipped countries. Long-distance speaking will also, it is hoped, increase, as the possibility has been proved of speaking 800 miles between New York and Chicago. Unfortunately the price (36s. for five minutes' conversation) is against its general adoption. "We must not be discouraged," concludes the *Journal Télégraphique*, "with the Chicago tariff; we hope, moreover, that much other progress will accrue to us from this extraordinary town. It is difficult to foresee all the surprises in store for us from the World's Fair. Will it give us induction at long distances without conducting wire, on the system recently set forth by Mr. Preece?"

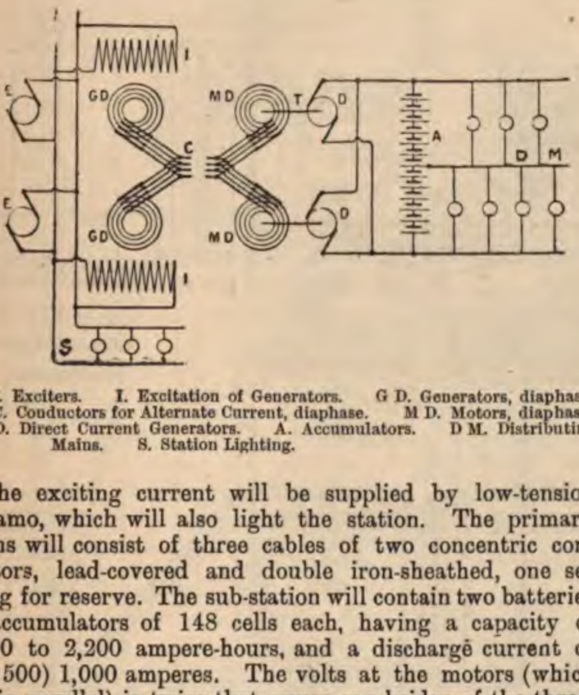
Visible Wiring.—The installation at the Royal Hotel, Blackfriars, is worth a visit from electrical engineers for several reasons. Not alone is it a very complete and compact plant—Babcock-Wilcox boilers, Willans-Siemens steam dynamos—supplying over 2,000 lights, fitted with every convenience and scientific apparatus for continuous running in parallel direct. This would entitle it, by reason of its accessibility in the centre of town and in a noted and well-patronised hotel, to favourable consideration as a fine example of electrical engineering practice. But from the electrical contractor's point of view, what will have most interest is the system of visible wiring adopted throughout the hotel under the supervision and arrangement of Messrs. Siemens's able foreman engineer, Mr. W. A. Collings. Every wire is visible: no wood casing is used except under exceptional circumstances; the thinnest insulation is employed on the cables; no piercing of walls has been allowed except for one or two mains; no floors have been taken up; all pendants are socket-connected. This may be taken as a radical departure back again towards the old wire-running system, yet with all the safeguards of modern practice. The hotel will be, and has been, visited by many engineers, architects, and intending customers, and we hear of several large West-end contracts to be arranged on this plan. The one consideration is—no hidden wires. Along the corridor cornices, copper cables just covered with blackened insulation (bare cables were intended at first) are led along in black china cleats plugged to the walls. The effect may be likened to a double string of huge black pearls, not at all unpleasing to the eye. The trunk mains are armoured, and come up the air-shaft to distribution switchboards and cut-outs. But the room branches are all run very neatly through the door frames, and the wires, three in number (one for the switch return), are strung in parallel lines—generally black, though sometimes whitened—on small china cleats to the cornice round the room. In every corner is a socket, from which runs a twin cord to a gilded ornamental ceiling rose, fixed without fuse, so that on cleaning the pendant can be taken down. The fuses are all outside, on the top of the door frames. Only behind curtains, or occasionally when passing within reach of hands or mechanical damage, is casing used for the wires. All the rest of the 40 odd miles in this large building is visible; and not a joint or connection but can be got at in a moment by the turn of a screw. Where the wires have to cross, a triple cleat is used, and the wires pass each other with a layer of china in between. Certainly the system has much to recommend it. Several fire insurance authorities have visited the installation, and Sir Polydore de Keyser seems to be immensely pleased with the general satisfactoriness of the installation. Another interesting point is the trip switches in the lavatories which trip on and off on opening and closing the doors. Again, in the engine-room the automatic main dynamo switches are worth attention. Two machines running in parallel keep their circuits closed by electromagnetic catches on a spring switch. If the load falls below that which can be supplied by one dynamo, all that is necessary to do is turn off steam, the E.M.F. drops, and current ceases in that part of the circuit, and the automatic switch being released at once springs off. No attention or moving of switch by hand is therefore required—the mere stopping of the engine is enough. A very clean and roomy engine-room has been built. The installation has one-third spare plant besides its old gas-engine and arc-light plant, already running for 10 years, to light the immense dining-room, which seats some 400 persons. The Royal Hotel, Blackfriars, is certainly an example of the latest practice in separate plants, and as it will be kept running night and day the effect can be seen by visitors at any time.

BUDAPEST.

A very interesting installation from the technical point of view is certainly one that is to be erected by the General Austrian Gas Company of Budapest for the lighting of that town. The system chosen includes both alternating and continuous current, not used separately, but organically connected together. The advantages of both are thus obtained: (1) Small section of long-line mains by the use of high-tension alternate currents, and (2) security of working and economy of distribution by the use of accumulators.

The generating station is situated two miles from the town. Plant for 10,000 16-c.p. lamps simultaneously lighted will first be installed. The mains are calculated for 16,000 lamps, but everything is arranged so as to be trebled in case of need. The distance of the station away determined the choice of the alternate current; from the main station two currents will be sent to a sub-station, with a difference of phase of a quarter period direct to two-phase motors coupled to continuous-current dynamos, which will feed the three-wire mains by the intermediary of a battery of accumulators.

The driving plant consists of two vertical triple-expansion steam-engines of 500 h.p., each driving a two-phase dynamo; the two dynamos will run in parallel, each giving about 100 amperes to each circuit at 1,800 volts, corresponding to 360 kilowatts each machine.



E E. Exciters. I. Excitation of Generators. G D. Generators, diaphase. C. Conductors for Alternate Current, diaphase. M D. Motors, diaphase. D. Direct Current Generators. A. Accumulators. D M. Distributing Mains. S. Station Lighting.

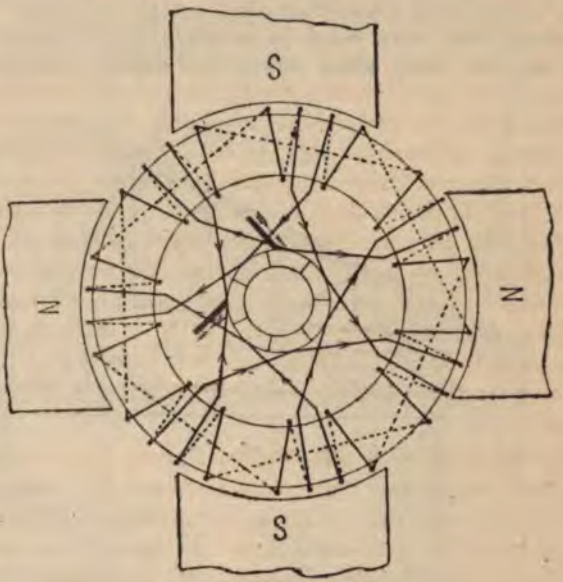
The exciting current will be supplied by low-tension dynamo, which will also light the station. The primary mains will consist of three cables of two concentric conductors, lead-covered and double iron-sheathed, one set being for reserve. The sub-station will contain two batteries of accumulators of 148 cells each, having a capacity of 1,500 to 2,200 ampere-hours, and a discharge current of (2 × 500) 1,000 amperes. The volts at the motors (which are in parallel) is twice that across one bridge of the three-wire system. The distribution is carried out in the usual manner by means of accumulators, with regulators to vary the number of cells. The entire installation is being carried out by Messrs. Schuckert, of Nurenberg, and part is to be ready for work in the coming winter.

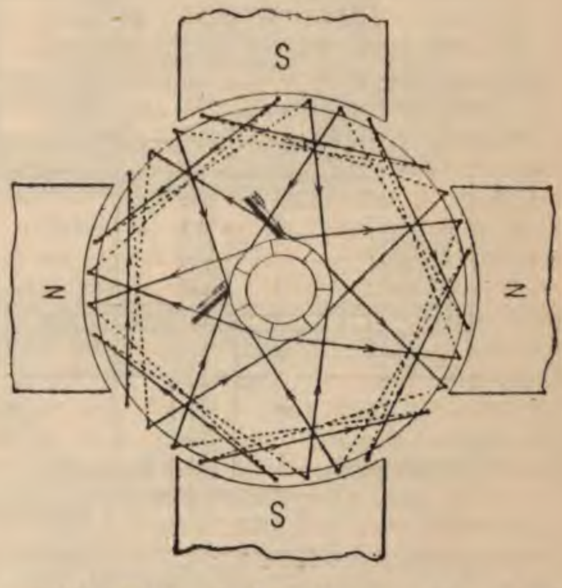
RING ARMATURE FOR MULTIPOLAR HIGH-TENSION MACHINES.*

BY LUDWIG BAUMGARDT.

Cylindrical armatures with closed winding for direct current are usually divided into two classes: (1) Drum armatures—that is, those in which only the outer surface is covered with wires; (2) ring armatures—that is, those in which both the exterior and interior surfaces of a hollow cylinder carry an equal number of turns of the wire. This classification, however, by no means exhausts all the possible kinds of armatures. On the contrary, there is a third kind, of more than theoretical importance, in which there are more turns on one surface than on the other. This last form of armature is of especial advantage in the construction of large direct-current machines of very high tension. Such machines are constructed with the multipolar arrangement, and with such a disposition of armature winding as will permit the greatest influence of the magnetic fields, so as to increase the tension. Armature windings of this class have been worked out by Perry* and Fritsche.†

The accompanying figure is a diagrammatic representation of the winding of a ring armature which belongs to the category last mentioned, with closed winding. If the reader will trace out the course of the current in this diagram, he will observe that there are two systems of winding in parallel, and that the increased tension is due to the four poles arranged, as shown to be most effective with this disposition of the circuit. If this arrangement be compared with that of the second figure, which represents the drum armature winding patented by Fritsche, it will be seen to possess the following advantages: First, the greater simplicity of workmanship due to the use of a ring; secondly, the avoidance of infringing any of the patent rights claimed by Fritsche. On the other hand, Fritsche is able (other conditions remaining similar) to make use of a greater number of segments for his collector. The lower limits of the allowable number of segments of the armature, with given total number of turns, are, however, considerably lessened since we have learnt to reduce the sparking to a minimum by the use of short badly-conducting lengths of wire going to the collector.





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* From the *Elektrotechnische Zeitschrift.*

* Silvanus Thompson, "Dynamo-electric Machinery, 1889," page 163.

† Fritsche, "Die Gleichstromdynamomaschine, 1889," s. 51.

THE TOULOUSE ELECTRICITY SUPPLY STATION.

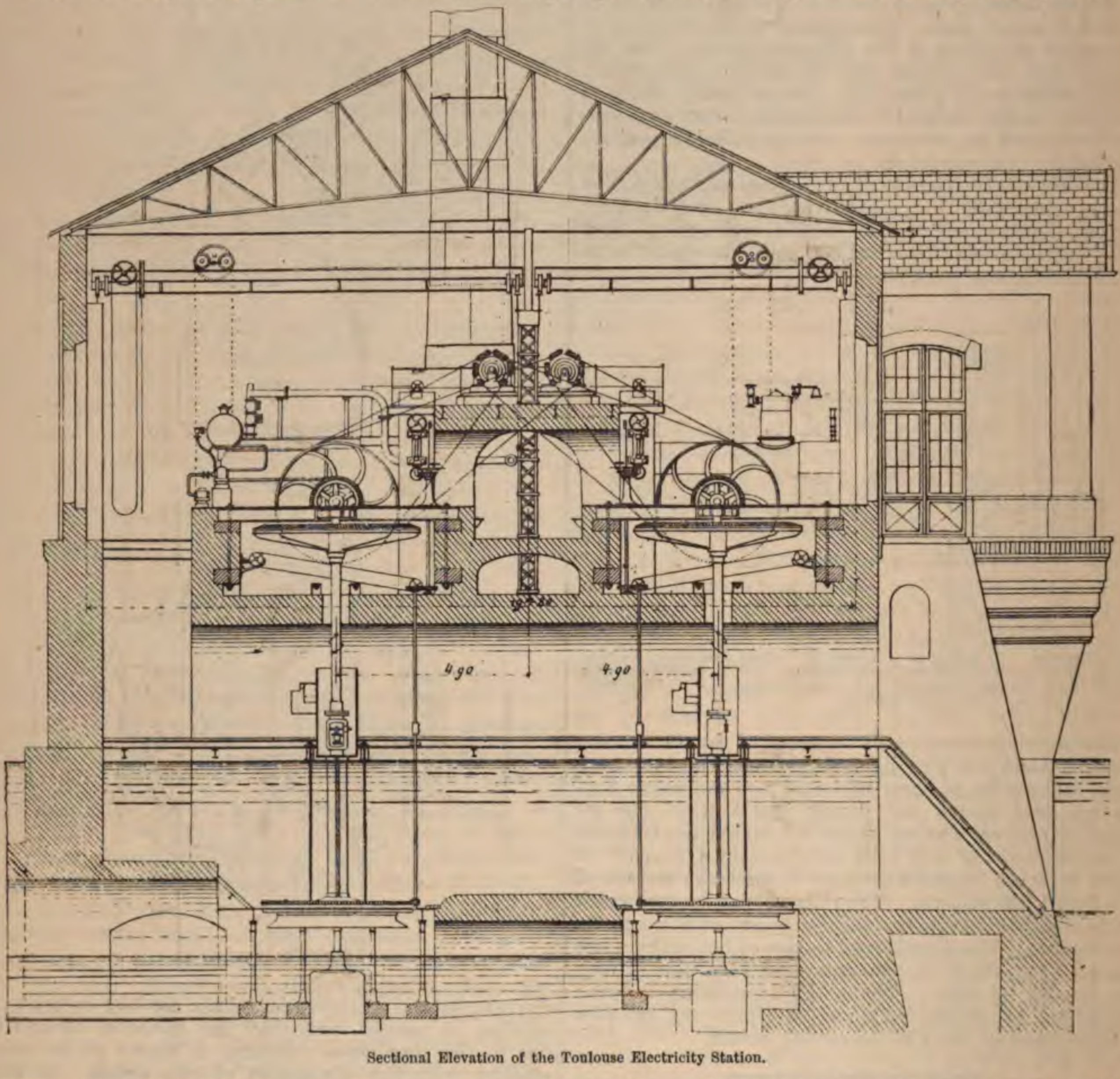
A company was formed in October, 1888, under the title of "La Société Toulousaine d'Electricité," for the purpose of supplying electric energy throughout this busy French town, both for public and private lighting, and for actuating stationary motors. To carry out this purpose, steps were forthwith taken to build and equip a large supply station in the centre of the town, where capital facilities existed for employing water power available from the River Garonne, and for this reason alone, therefore, considerable interest attaches to the enterprise. It is certain that very much more might be attempted in the way of using water power for electric generating stations than has hitherto been done, and it is to be hoped that the results from the Niagara and other great installations will prove conclusively the vast scope that is possessed by turbines as prime movers in the direction of efficiency and economy.

Returning, however, to the Toulouse station, some details (most of which are derived from a long and well illustrated description in the *Genie Civil*) may now be given with respect to the generating plant.

The entire installation was designed to feed about 12,000 lamps of 10 c.p. each, or their equivalent, and the mechanical unit adopted in the station was therefore one of 300 h.p. The turbines decided upon were of the Girard type, four in number, and each of these—under the full head of 14ft. 8in.—developes 320 h.p. on the turbine shaft.

The regulating gear, which governs the flow of water *through* the turbine blades, is operated by means of a long vertical shaft brought up through the water-chamber into the dynamo-room, and there rotated either by hand or mechanically. On the upper end of each turbine shaft is mounted a large bevel spur wheel about 11ft. 6in. diameter, with wooden teeth set in an iron casting. Gearing with these wheels are four small pinions mounted upon two horizontal shafts running lengthways of the dynamo-house, as will be seen from the accompanying plan and elevation; the whole work of the station—whether by the turbines or auxiliary engines—is carried out by these two shafts. Upon each of them, at suitable points, are mounted four pulleys, about 10ft. diameter and 20in. face, from which are driven the dynamos by endless belts of triple leather.

The dynamos themselves are fixed on a sort of gallery or superstructure built upon arches running midway between the turbine shafts; this is partly to get a longer drive for the dynamo belts, and partly to leave more room on the main floor, where ease of access to the countershafts and auxiliary engines is essential.

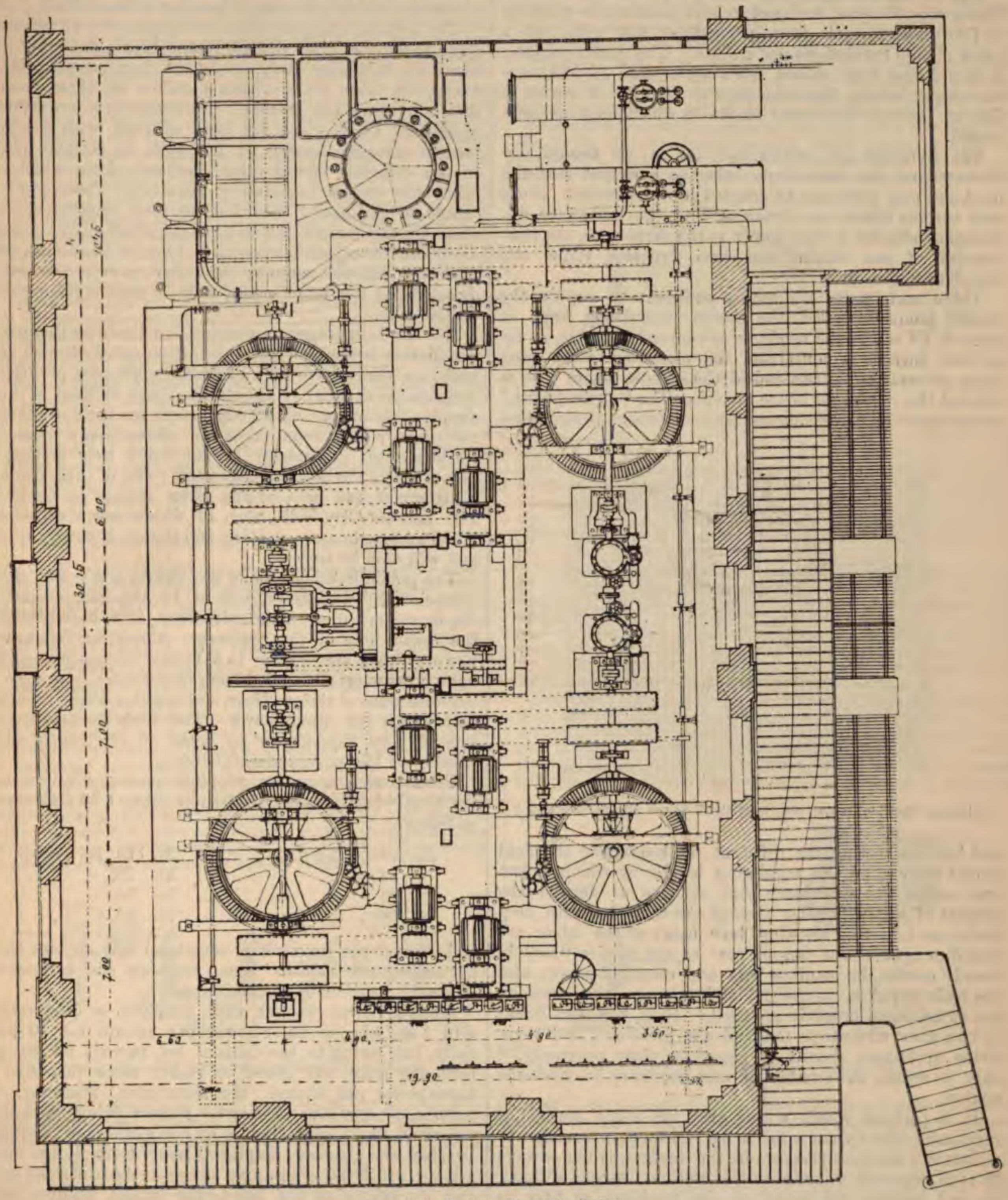


Sectional Elevation of the Toulouse Electricity Station.

It has been found necessary to instal additional motive power in the shape of steam-engines, by reason, first, of the rapid development in the demand for electric energy throughout the town, and, second, because the water power available is to some extent limited in amount, not only in actual quantity, but also in the head or fall, owing to the rapid flow of the Garonne. Accordingly—as will be noticed on the plan—a separate set of steam-engines is employed to actuate each of the two horizontal shafts already mentioned as serving to operate the dynamos. Each set of engines is put in the middle of the shafting length, between the two turbines, and is connected with the shafting on either side by means of a clutch coupling.

When, therefore, the turbines are running, the engines are thrown out altogether by the clutches; but if through lack of water, or a reduction of the available head, the turbines should not be sufficiently powerful to properly work the dynamos, the bevel spur wheels are thrown out of gear by withdrawing the small pinions on the horizontal shafts, keyways—with feathers—being cut for the purpose. The clutches between the engines and shafting are then closed, and the dynamos then driven entirely by the engines. The latter comprise, as stated, two sets—one for each horizontal shaft. One is of a compound horizontal type rated at 320 h.p.; the other set is formed of two ordinary high-pressure or simple single-cylinder engines, rated at 250 h.p. Both sets are designed to use condensers, the latter at will, according as may be desirable.

The boilers from which is drawn a steam supply for the engines, are also separated into two groups; one of these contains three semi-portable locomotive type boilers of 150 h.p. capacity, and the other, three multitubular boilers of the Collet pattern. Both sets of boilers discharge their waste furnace gases into a sheet-iron chimney about 6ft. in diameter at the top, with a height of about 156ft. The pipes to and from all feeding apparatus—boiler pumps, injectors, etc.—are in duplicate throughout, so as to prevent any possible accident to one set from cutting off the supply of energy out of the station; and in order to make the steam connections elastic or flexible in the method of working, they are so arranged that any engine can be supplied from any one of the five boilers installed, and if necessary can be changed over from one to another whilst running.



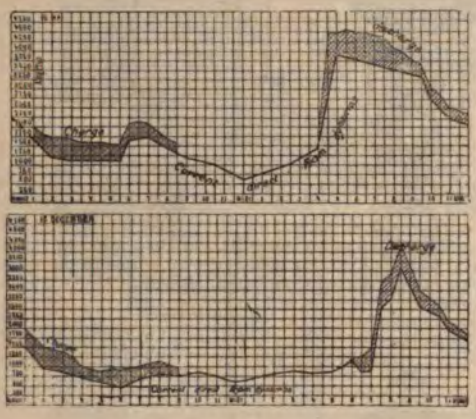
Plan of the Toulouse Electricity Station.

Careful arrangements are also made throughout the station for proper lubrication of all working parts with a view to possible long runs, and particular attention appears to be paid on this account to the turbine steps or pivots. For these it was found that oil did not give complete satisfaction, and—as in a great number of machine tools—much better results were obtained from the use of soapy water. This is produced by simply trickling water from an ordinary pipe and cock into a tray containing soap and fitted into the top of a vessel with two compartments. The soapy water passes through holes in the base of the partition between the two compartments into the second one, and then flows down a pipe into a cylindrical tray fitted round the vertical turbine shaft. Thence it falls through another pipe into the bearing itself.

The dynamos employed in this station are all of the Thury six-pole type, designed to give continuous currents of 700 amperes each at a pressure of 150 volts and a speed of 380 revolutions per minute. The steam-engines, it should have been stated, work at a speed of 120 revolutions per minute, the same angular velocity of course as that of the two horizontal shafts to which they are connected.

The dynamos are self-excited, or, as we should say shunt-wound, the connections being so arranged that the machines may with ease be coupled up in parallel. Since each turbine drives two dynamos, and the system of distribution adopted is that known as the three-wire, the combination of one turbine and two dynamos forms one complete station unit.

Three such units are amply sufficient to supply the 12,000 lamps installed, the fourth unit being kept in reserve. Of course the machines are interchangeable, so far as their current is concerned, the necessary switch gears being all arranged at one end of the station, where also is effected the regulation of the turbines. The "switchboard," indeed is of a double form, one part comprising the switches and bars connecting the different machines, also the field circuit resistances, the regulating handle by which is put into action the machinery that changes as desired the amount of water flowing through the turbine blades, and, lastly, an indicator showing how many of the latter are closed or open. The second part of the station "switchboard" carries the omnibus bars and circuit feeders; also the main switches, ammeters, and cut-outs, thus forming the switchboard properly so-called. It is, however, found to be a great advantage that all the governing and regulating appliances should be placed in close proximity, if only to reduce the number of men necessary to work the station.



Diagrams Showing Output, etc., from the Toulouse Electricity Station.

It is perhaps worth noting that the usual method of regulating the dynamo fields by resistances, in order to maintain a constant pressure in the feeders, is not always or even generally followed in this station; instead of doing so, and keeping the speed of the machines as near as possible constant, the speed of generators, and therefore of dynamos, is varied according as the voltage requires. The claim is made that by such regulation sudden changes are avoided by reason of the mere weight and mass of the parts to be altered or moved—as for instance, the arrangement of gates, etc., by which is regulated the flow of water past the turbine vanes. The turbine, turbine shaft, and bevel gear wheel weigh approximately 17 tons, and run at 40 revolutions per minute. In spite, however, of the considerable weights to be moved, one man alone is required to operate the whole station. This result is obtained by the use of two subsidiary turbines of 30 h.p. to do the heavy work of moving the regulators, these smaller motors being put into operation or thrown out by connections brought right up to the switchboard.

Four men in all are therefore needed to run the station under such conditions—one, the responsible head, at the switchboard, where he may govern not only the electrical but the mechanical arrangements. The other three are simply assistants or labourers required to watch the dynamos, countershaft, and turbines, supplying oil when necessary, and in other ways keeping strict outlook.

The circuits operated from the station are all of them quite short, the most distant lamps being not more than one and a half miles away, whilst the chief consumption of energy all takes place within a radius of three-quarters of a mile from the station. Consequently a low-pressure system of three wires has been adopted, with overhead feeders carrying current at 125 volts to suitable points in the complete circuit (also overhead), from which are taken the various branches as required. These are connected to the mains according to their importance; the small electric motors, for instance (of which quite a number are in use for various purposes), of 1 h.p. or less are supplied from the 125-volt circuit; the larger ones are connected direct to the two outer mains, so as to use the full pressure of 250 volts.

Not the least interesting part of the Toulouse Company's installation is the plan of employing sub-stations with accumulators, which have been of necessity adopted in order to increase the capacity of the station above its limit of direct supply—the output of 12,000 lamps or their equivalent having very soon been taken up. Accordingly these sub-stations—two in number so far—have been erected at points where the demand is greatest: one of them contains a battery of 145 cells of the Betts type; the other has 150 Laurent-Cèly cells, each of which has a capacity of 3,600 ampere-hours. A third sub-station is now proposed, and will soon be erected.

The public lighting—along the streets and boulevards—comprises 208 arc lamps, each of 10 amperes, erected for the most part upon standards about 20ft. high placed in the centre line of the roadway. Along the boulevards, however, they are—owing to a variety of reasons—strung upon cross-wires suspended from ornamental iron posts on opposite sides of the roadway, and are at a height of nearly 30ft. above the ground-level. The town markets are also lighted very handsomely by some 20 arc lamps and a number of 10-c.p. incandescent lights.

Private consumers are supplied generally by contract, the tariff—from one hour before sunset to 1.30 a.m.—being as follows:

Per 10-c.p. lamp................	2s. 11d. per month.
16 ,, ...	4s. 7d. ,,
20 ,, ...	5s. 5d. ,,
30 ,, ...	7s. 6d. ,,

and for each arc lamp taking more than four amperes 4s. 2d. per ampere per month. Lamp renewals and carbons are, of course, paid for by the consumer.

Motive power was at first supplied at the rate of £16. 13s. 4d. per horse-power per annum for 10 hours daily, but owing to the demand for current for this purpose the price was raised to rather more than £20 per horse-power per annum, the cleanliness, efficiency, and other good qualities of electric motors being responsible for their rapid appreciation by the workers of Toulouse. In size the motors employed vary from ½ h.p. up to 4 h.p.; nearly 80 are in use amongst the different trades and workshops of the town, the largest number being found in printing and lithographing establishments.

Current is also supplied by meter, the Cauderay-Frager, Thomson, and Brillié instruments being principally used.

Besides private consumers and the public lighting, the Toulouse Company also supplies the post and telegraph offices (lighted wholly and solely by this means), the artillery barracks, the cathedral, and many other large buildings. The total number of lights supplied with current amounted at the end of 1892 to 13,682 lamps of 10 c.p., or their equivalent, whilst the electric motors in use by consumers throughout the town reached a total capacity of rather more than 125 h.p.

ON LIGHT AND OTHER HIGH-FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

(Continued from page 634.)

This bulb verified my expectation, for the filament was set spinning when the current was turned on, and became incandescent. It also showed another interesting feature, bearing upon the preceding remarks—namely, when the filament had been kept incandescent some time, the narrow tube and the space inside were brought to an elevated temperature, and as the gas in the tube then became conducting, the electrostatic attraction between the glass and the filament became very weak or ceased, and the filament came to rest. When it came to rest it would glow far more intensely. This was probably due to its assuming the position in the centre of the tube where the molecular bombardment was most intense, and also partly to the fact that the individual impacts were more violent, and that no part of the supplied energy was converted into mechanical movement. Since, in accordance with accepted views, in this experiment the incandescence must be attributed to the impacts of the particles, molecules, or atoms in the heated space, these particles must, therefore, in order to explain such action, be assumed to behave as independent carriers of electric charges immersed in an insulating medium; yet there is no attractive force between the glass tube and the filament because the space in the tube is, as a whole, conducting.

It is of some interest to observe in this connection that whereas the attraction between two electrified bodies may cease owing to the impairing of the insulating power of the medium in which they are immersed, the repulsion between the bodies may still be observed. This may be explained in a plausible way. When the bodies are placed at some distance in a poorly conducting medium, such as slightly warmed or rarefied air, and are suddenly electrified, opposite electric charges being imparted to them, these charges equalise more or less by leakage through the air. But if the bodies are similarly electrified, there is less opportunity afforded for such dissipation, hence the repulsion observed in such case is greater than the attraction. Repulsive actions in a gaseous medium are, however, as Prof. Crookes has shown, enhanced by molecular bombardment.

ON CURRENT OR DYNAMIC ELECTRICITY PHENOMENA.

So far, I have considered principally effects produced by a varying electrostatic force in an insulating medium, such as air. When such a force is acting upon a conducting body of measurable dimensions, it causes within the same, or on its surface, displacements of the electricity and gives rise to electric currents, and these produce another kind of phenomena, some of which I shall presently endeavour to illustrate. In presenting this second class of electrical effects, I will avail myself principally of such as are producible without any return circuit, hoping to interest you the more by presenting these phenomena in a more or less novel aspect.

It has been for a long time customary, owing to the limited experience with vibratory currents, to consider an electric current as something circulating in a closed conducting path. It was astonishing at first to realise that a current may flow through the conducting path even if the latter be interrupted, and it was still more surprising to learn that sometimes it may be even easier to make a current flow under such conditions than through a closed path. But that old idea is gradually disappearing, even among practical men, and will soon be entirely forgotten.

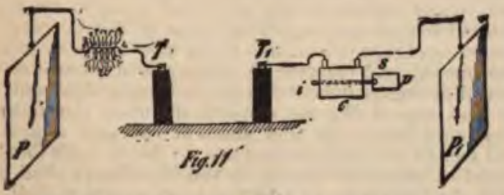


Fig. 11

Showing Effects of Currents Flowing through Open Circuits.

If I connect an insulated metal plate, P, Fig. 11, to one of the terminals, T, of the induction coil by means of a wire, though this plate be very well insulated, a current passes through the wire when the coil is set to work. First I wish to give you evidence that there is a current passing through the connecting wire. An obvious way of demonstrating this is to insert between the terminal of the coil and the insulated plate a very thin platinum or German-silver wire, *w*, and bring the latter to incandescence or fusion by the current. This requires a rather large plate or else current impulses of very high potential and frequency. Another way is to take a coil, C, Fig. 11, containing many turns of thin insulated wire, and to insert the same in the path of the current to the plate. When I connect one of the ends of the coil to the wire leading to another insulated plate, P, and its other end to the terminal, T_1, of the induction coil, and set the latter to work, a current passes through the inserted coil, C, and the existence of the current may be made manifest in various ways. For instance, I insert an iron core, *i*, within the coil. The current being one of very high frequency, if it be of some strength, will soon bring the iron core to a noticeably higher temperature, as the hysteresis and current losses are great with such high frequencies. One might take a core of some size, laminated or not, it would matter little; but ordinary iron wire, $\frac{1}{16}$th or $\frac{1}{8}$th of an inch thick, is suitable for the purpose. While the induction coil is working a current traverses the inserted coil, and only a few moments are sufficient to bring the iron wire, *i*, to an elevated temperature sufficient to soften the sealing-wax, *s*, and cause a paper washer, *p*, fastened by it to the iron wire to fall off. But with the apparatus such as I have here, other much more interesting demonstrations of this kind can be made. I have a secondary, S, Fig. 12, of coarse wire, wound upon a coil similar to the first. In the preceding experiment the current through the coil, C (Fig. 11), was very small, but there being many turns a strong heating effect was, nevertheless, produced in the iron wire. Had I passed that current through a conductor in order to show the heating of the latter, the current might have been too small to produce the effect desired. But with this coil provided with a secondary winding, I can now transform the feeble current of high tension which passes through the primary, P, into a strong secondary current of low tension, and this current will quite certainly do what I expect. In a small glass tube (*t*, Fig. 12) I have enclosed a coiled platinum wire, *w*—this merely in order to protect the wire. On each end of the glass tube is sealed a terminal of stout wire to which one of the ends of the platinum wire, *w*, is connected. I join the terminals of the secondary coil to these terminals and insert the primary, *p*, between the insulated plate, P_1, and the terminal, T_1, of the induction coil as before. The latter being set to work, instantly the platinum wire, *w*, is rendered incandescent and can be fused even if it be very thick.

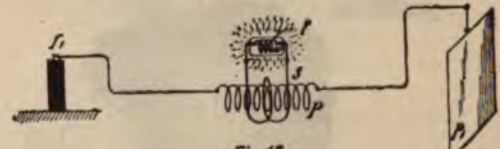


Fig. 12

Conversion on Open Circuit with Coil and Insulated Plate.

Instead of the platinum wire I now take an ordinary 50-volt 16-c.p. lamp. When I set the induction coil in operation the lamp filament is brought to high incandescence. It is, however, not necessary to use the insulated plate, for the lamp (*l*, Fig. 13) is rendered incandescent, even if the plate, P_1, be disconnected. The secondary may also be connected to the primary as indicated by the dotted line in Fig. 13, to do away, more or less, with the electrostatic induction, or to modify the action otherwise.

I may here call attention to a number of interesting observations with the lamp. First, I disconnect one of the terminals of the lamp from the secondary, S. When the induction coil plays, a glow is noted which fills the whole bulb. This glow is due to electrostatic induction. It increases when the bulb is grasped with the hand, and the capacity of the experimenter's body thus added to the secondary circuit. The secondary, in effect, is equivalent to a metallic coating, which would be placed near the primary. If the secondary, or its equivalent, the coating, were placed symmetrically to the primary, the electrostatic induction would be nil under ordinary conditions—that is, when a primary return circuit is used—as both halves would neutralise each other. The secondary is, in fact, placed symmetrically to the primary, but the action of both halves of the latter. when only one of its ends is connected to the induction coil, is not exactly equal; hence, electrostatic induction takes place, and hence the glow in the bulb. I can nearly equalise the action of both halves of the primary by connecting the other free end of the same to the insulated plate, as in the preceding experiment. When the plate is connected, the glow disappears. With a smaller plate it would not entirely disappear, and then it would contribute to the brightness of the filament when the secondary is closed, by warming the air in the bulb.

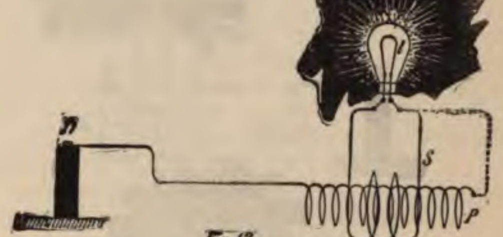


Fig. 13

Conversion on Open Circuit with Coil alone.

To demonstrate another interesting feature, I have adjusted the coils used in a certain way. I first connect both the terminals of the lamp to the secondary, one end of the primary being connected to the terminal, T_1, of the induction coil, and the other the insulated plate, P_1, as before. When the current is turne the lamp glows brightly, as shown in Fig. 14*b*, in which C is a fine-wire coil, and S a coarse-wire secondary wound upon it. If the insulated plate, P_1, is disconnected, leaving one of the ends, *a*, of the primary insulated, the filament becomes dark, or generally it diminishes in brightness, Fig. 14*a*. Connecting again the plate, P_1, and raising the frequency of the current, I make the filament quite dark or barely red, Fig. 15*b*. Once more I will disconnect the plate. One will of course infer that when the plate is disconnected the current through the primary will be weakened, that therefore the E.M.F. will fall in the secondary, S, and that the brightness of the lamp will diminish. This might be the case, and the result can be secured by an easy adjustment of the coils; also by varying the frequency and potential of the currents. But it is perhaps of greater interest to note that the lamp increases in brightness when the plate is disconnected, Fig. 15*a*. In this case all the energy the primary receives is now sunk into it, like the charge of a battery in an ocean cable, but most of that energy is recovered through the secondary and used to light the lamp. The current traversing the primary is strongest at the end, *b*, which is connected to the terminal, T_1, of the induction coil, and diminishes in strength towards the remote end, *a*. But the dynamic inductive *effect* exerted upon the secondary, S, is now greater than before, *when the suspended* plate was connected to the primary. These *results might* have been produced by a number of causes. For instance, the plate, P_1, being connected, the reaction from the coil, C, may be such as to diminish the potential at the terminal, T_1, of the induction coil, and therefore weaken the current through the primary of the coil, C. Or the disconnecting of the plate may diminish the capacity effect with relation to the primary of the latter coil to such an extent that the current through it is diminished, though the potential at the terminal, T_1, of the induction coil may be the same or even higher. Or the result might have been produced by the change of phase of the primary and secondary currents and consequent reaction. But the chief determining factor is the relation of the self-induction and capacity of coil, C, and plate, P_1, and the frequency of the currents. The greater brightness of the filament in Fig. 15*a* is, however, in part due to the heating of the rarefied gas in the lamp by electrostatic induction, which, as before remarked, is greater when the suspended plate is disconnected.

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* A lecture delivered before the Franklin Institute, at Philadelphia, February 24, 1893; and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

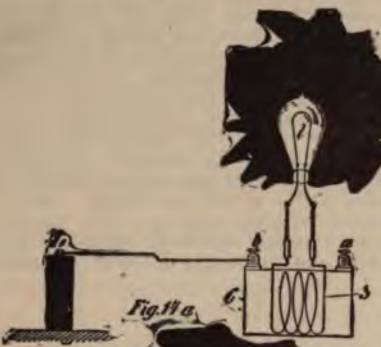

Fig.14a

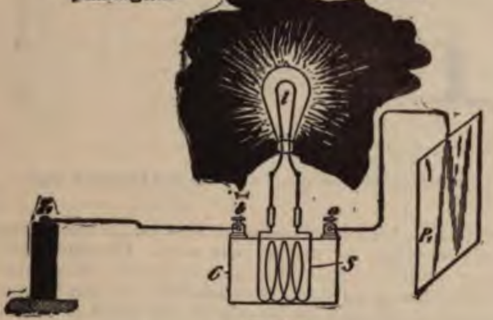

Fig.14b

Effect of Attached Plate with Low Frequencies.

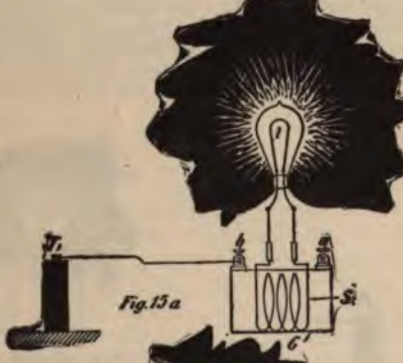

Fig.15a

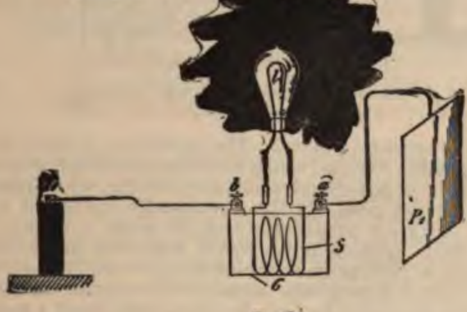

Fig.15b

Effect of Attached Plate with High Freqnencies.

Still another feature of some interest I may here bring to your attention. When the insulated plate is disconnected and the secondary of the coil opened, by approaching a small object to the secondary, but very small sparks can be drawn from it, showing that the electrostatic induction is small in this case. But upon the secondary being closed upon itself or through the lamp, the filament glowing brightly, strong sparks are obtained from the secondary. The electrostatic induction is now much greater, because the closed secondary determines a greater flow of current through the primary and principally through that half of it which is connected to the induction coil. If now the bulb be grasped with the hand, the capacity of the secondary with reference to the primary is augmented by the experimenter's body and the luminosity of the filament is increased, the incandescence now being due partly to the flow of current through the filament and partly to the molecular bombardment of the rarefied gas in the bulb.]

(*To be continued.*)

ELECTRIC CONSTRUCTION CORPORATION.

We have received the following circulars:

Notice is hereby given that an extraordinary general meeting of the above-named Company will be held at the Cannon-street Hotel, in the City of London, on Wednesday, the fifth day of July, 1893, at three o'clock in the afternoon, for the purpose of considering and, if thought fit, passing the following resolutions as special resolutions—viz.:

"1. That it is desirable that the Corporation be reconstructed, and that with a view to such reconstruction the Corporation be wound up voluntarily.

"2. That the liquidators be, and they are hereby, authorised to consent to the incorporation of a company (hereinafter called "the new company") with the name of "The Electric Construction Company, Limited," or such other name as the liquidators may approve.

"3. That the capital of the new company be £400,000 divided into 150,000 ordinary shares of £2 each, and 50,000 7 per cent. cumulative preference shares of £2 each.

"4. That the memorandum and articles of association of the new company be in such form as the liquidators shall approve.

"5. That in accordance with the provisions of Section 161 of the Companies Act, 1862, the liquidators be and they are hereby authorised to transfer to the new company, as from the 1st of July, 1893, all the assets and undertaking of the Corporation, upon the terms that the new company shall pay or satisfy all the debts and liabilities of the Corporation, including the costs of the winding-up and reconstruction, and shall issue to the holders of the first and second mortgage debentures of the Corporation first and second mortgage debentures of the new company of the same nominal amount, and carrying the same rate of interest as the first and second mortgage debentures of the Corporation, and ranking as first and second charges respectively upon the undertaking, property, uncalled capital, and assets of the new company, such first and second mortgage debentures to be in such form, and to be secured by such trust deeds as the liquidators shall approve, and upon the further terms that the new company shall issue to the liquidators, as they may direct, 120,000 fully-paid ordinary shares, and 14,630 fully-paid preference shares of the new company.

"6. That the 120,000 fully-paid ordinary shares of the new company be distributed as follows: (*a*) To the holders of income bonds of the Corporation two shares for every £10 of income bonds in satisfaction of such bonds. (*b*) To the holders of founders' shares of the Corporation two shares for every founder's share. (*c*) To the holders of ordinary shares of the Corporation two shares for every ordinary share of the Corporation.

"7. That the 14,630 fully-paid preference shares of the new company be distributed among the holders of the preference shares of the Corporation in the proportion of five fully-paid preference shares of the new company (£10) for every fully-paid preference share of the Corporation.

"8. That the liquidators be, and they are hereby, authorised to enter into such agreements with the new company or a trustee for the new company, and generally to do all such acts and things as they may think expedient for carrying the reconstruction into effect."

Notice is hereby also given, that in case the above resolutions are passed, the same will be submitted to a second extraordinary general meeting, which will be called for the purposes of confirming the same as special resolutions and of appointing liquidators.

STATEMENT SHOWING THE CAPITAL OF THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED, AND THE CAPITAL OF THE PROPOSED NEW COMPANY.

Capital of the Electric Construction Corporation, Limited.		*To be exchanged for*	Capital of the new company to be issued in exchange.	
6 per cent. mortgage debentures, in bonds of £100 each	£150,000		6 per cent. first mortgage debentures, operating as a first charge upon the undertaking and property of the company, and secured by trust deed.....	£150,000
			Of these, £24,600 will be deposited as security, but will be available for issue.	
6 per cent. second mortgage debentures, redeemable by half-yearly drawings within 15 years, with income bond of equal amount attached, entitled upon redemption of the corresponding debenture to rank in front of the ordinary shares and to bear interest at a rate equal to dividend paid on ordinary shares	100,000	*do.*	6 per cent. second mortgage debentures, to rank next after the first mortgage debentures secured by trust deed, redeemable by half-yearly drawings within 15 years..	100,000
Income bonds	100,000		*Of these, £50,000 will be deposited as security, but will be available for issue.*	
			20,000 ordinary shares of £2 each, fully paid in exchange for the income bonds........	40,000
			Of these, 10,000 shares will be issued and held as security.	
7 per cent. cumulative preference shares of £10 each	29,260	*do.*	14,630 fully-paid 7 per cent. cumulative preference shares of £2 each	29,260
Ordinary shares of £10 each, entitled to surplus profits up to 10 per cent., and to one-half of remaining profits..............	499,000	*do.*	99,800 fully-paid ordinary shares of £2 each, in the proportion of two new shares for one old	199,600
100 founders' shares of £10 each, entitled to one-half of surplus profits after 10 per cent. has been paid on ordinary shares	1,000	*do.*	200 do. do. do.	400
	£879,260			£519,260

To the Shareholders of the Electric Construction Corporation, Limited.

Sir or Madam,—1. Since the last general meeting your directors have carefully considered the best means of placing the Corporation in a sound commercial and financial position, and they are glad to be able to report satisfactory progress in this direction.

2. Important reductions have been made in the general expenses, the directors have reduced their remuneration, and such further economies as will not interfere with efficiency will be introduced as opportunity offers.

3. During the past year seven directors have vacated their seats, and three new directors have been appointed, and the Board has thus been practically reconstituted.

4. The directors, recognising the necessity of a commercial manager for the economical and efficient administration of the business, consider themselves fortunate in having secured as managing director Mr. Emile Garcke, whose experience and success as manager for several years of the Brush Electrical Engineering Company specially qualify him for the position.

5. Mr. James Gray has recently been appointed secretary.

6. The directors have also much pleasure in reporting that the important engineering and manufacturing contracts carried out by the works director, Mr. Thomas Parker, have not only given entire satisfaction, but established for the Corporation a high reputation for excellence of design and workmanship.

7. In accordance with the views expressed at the general meeting, it has been the duty of the reconstituted Board to determine, according to the best of their judgment, whether the capital of the Corporation is adequately represented by its assets, and after careful and anxious deliberation the directors have come to the conclusion that a rearrangement of capital by reconstruction is both expedient and necessary. This, they are of opinion can be most advantageously carried out by the formation of a new company with reduced capital.

8. As a consequence of the reconstruction, future profits would be applicable to payment of dividends instead of to making good the deficiency on capital account.

9. It is proposed that the new company shall be called "The Electric Construction Company, Limited," with a nominal share capital of £400,000, divided into 150,000 ordinary shares of £2 each and 50,000 7 per cent. cumulative preference shares of £2 each, with £150,000 first mortgage debentures and £100,000 second mortgage debentures, the latter redeemable by half-yearly drawings in about 15 years; and that the capital of the Corporation be exchanged for capital in the new company on the following terms: (*a*) Ordinary shareholders to receive two fully-paid £2 shares of the new company for each fully-paid £10 share of the Corporation. (*b*) Preference shareholders to receive five fully-paid 7 per cent. cumulative preference shares of £2 each (£10) for each £10 fully-paid 7 per cent. fully-paid cumulative preference share of the Corporation. (*c*) Holders of founders' shares to receive two fully-paid £2 ordinary shares of the new company for each £10 founder's share of the Corporation. (*d*) Holders of first and second mortgage debentures to receive first and second mortgage debentures of the new company of the same nominal amounts, and carrying the same rate of interest, as the first and second mortgage debentures of the Corporation. (*e*) Holders of income bonds to receive two fully-paid ordinary shares of £2 each for each income bond of £10. The first mortgage debentures will constitute a first charge, and the second mortgage debentures a second charge upon the property, assets, and undertaking of the new company, present and future, and each series will be secured by a separate trust deed, with the same trustees as those now acting under the existing trust deeds. The statement annexed hereto shows the present capital of the Corporation and the capital of the proposed new company, to be issued in exchange.

10. It is proposed that the new company shall take over the business with all liabilities and assets as from July 1, 1893.

11. The works of the Corporation at Bushbury are generally admitted to be the best of their kind in the kingdom, and the plant is specially adapted to the business, and is in very good condition. The patents owned by the Corporation are valuable, and the electro-chemical patents taken out by Mr. Parker and the technical staff especially give good promise of profitable results.

12. The ability of the Corporation to carry out large and important contracts has been shown by the successful completion of the Liverpool Overhead Electric Railway, of the South Staffordshire Electric Tramways, and of numerous electric lighting contracts and other applications of electricity in London and the provinces.

13. Having most carefully considered the whole position, the directors are of opinion that the capital of the new company will be fairly represented by its assets, and that the proposed reconstruction deals equitably with the various interests, and places the company in a strong position for doing such an amount of profitable work as may be reasonably expected to yield a satisfactory return upon the reduced capital.

14. By reason of the reorganisation of the business, which has been in progress for some months past, it is impracticable at present to give the result of the working during the portion of the year which has elapsed, but perhaps the best evidence of the confidence of the Board in the future of the company is that several of its members have since the last general meeting acquired shares, advanced money, or otherwise supported the Corporation to an amount exceeding £30,000.

15. Accompanying this report is notice of a special meeting to consider and, if deemed advisable, to pass the resolutions appended. It is hoped that all shareholders will endeavour to attend, but forms of proxy are issued to enable shareholders to express their conclusion on the proposals now submitted.

The Board attach much importance to having the support of every shareholder.

On behalf of the Board, DANIEL COOPER, Chairman.

Worcester House, Walbrook, E.C., June 26, 1893.

TESTS FOR INDIARUBBER.

A series of tests have been recently carried out by a Russian naval officer at the St. Petersburg Technical Institute in order to establish a set of definite rules for judging the quality of vulcanised indiarubber. The following, in brief, are the conclusions arrived at, recourse being had to physical properties, since chemical analysis did not give reliable results: 1. Indiarubber should not give the least sign of superficial cracking when bent to an angle of 180deg. C. after five hours of exposure in a closed air bath to a temperature of 125deg. C. The test-pieces should be 2·4in. thick. 2. Rubber that does not contain more than half its weight of metallic oxides should stretch to five times its length without breaking. 3. Rubber free from all foreign matter, except the sulphur used in vulcanising it, should stretch to at least seven times its length without rupture. 4. The extension measured immediately after rupture should not exceed 12 per cent. of the original length, with given dimensions. 5. Suppleness may be determined by measuring the percentage of ash formed in icineration. This may form the basis for deciding between different grades of rubber for certain purposes. 6. Vulcanised rubber should not harden unde cold. These rules have been adopted for the Russian navy.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. X. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers have their own copies bound for 2s. 6d., or covers for binding obtained, price 2s*

MISLEADING THE POPULACE.

Perhaps it is an error in electrical tactics if we, instead of considering the value of the evidence before the Joint Committee (the concluding portion of which is given in our pages elsewhere), call attention once more to the silly stupidity of the ordinary newspaper. Electricity may be a name to conjure with, its applications may be numerous, may be wonderful, yet we hold that some care should be taken in promulgating statements which a schoolboy would laugh at. Fancy giving serious consideration to the statement that the recent drought in Europe has been caused by the multiplicity of telegraph wires! Of course, the suggestion comes from America, and is put in the plausible way that these wires have a great effect upon atmospheric electricity, and hence upon the rainfall. If history is read aright, Babylon was once a fertile district, or rather the city was in a fertile district, but the land is now an arid desert. Inference might suggest that the ancient Chaldeans knew all about electricity, and used overhead wires to their own detriment and the destruction of their country. Electrical engineers who are patriots first and electricians after should look to this. The very developments they carry out may each and all conduce to render their country one of the rainless wastes upon the surface of the earth. Unfortunately, where one person reads a technical journal, ten thousand read the papers which insert these silly paragraphs, and the statements made therein have a knack of sticking in the minds of the readers. Even at the end of this nineteenth century most people believe what they see in print. It would not be there, they argue, if it were not true; hence, no doubt, many men during the rainy season will look upon telegraph and telephone wires with a fetish-like affection, and some may suggest to their member to ask a question in Parliament about the advisability of erecting more wires to stop the rain. Better suggest a national trellis-work of metal which can be closed when rain is wanted, and opened when fine weather is required, while you are about it. Such a suggestion would be quite as valuable as many discussed seriously by the Legislature during this sultry summer weather. But the weather is not alone affected by electricity. The human frame is to be purged by electric pills, and its pains are to be alleviated by electric plasters, as we are told its ills are by electric belts—only the law courts do not seem to see it in that light. Blotting-paper that is rapidly absorbent is termed electric, not to speak of "magnetic" hair-brushes and boots. Tooth-powder is "electric"; in fact, the term is tacked on to everything where the sellers think it will conduce to selling. If some of our readers could see the hundreds of papers we are compelled to see, and examine the advertisement columns, they would come probably to the conclusion that half the newspaper literature of the day lived upon quack advertisements and a goodly proportion of these advertisements are about electric something or other. We contend that both by these paragraphs and by admitting these advertisements, the general public is led astray. It shows how much they are misled, because unless they were large purchasers of the articles advertised, it would be impossible for the advertisers to pay the enormous sums that must necessarily be paid. We have some right, then, to ask at anyrate, if the £ s. d. portion is not given up, that the misleading paragraphs in the body of the paper should be avoided. Either these electrical brushes, boots, combs, pills, etc., are beneficial or they are not. If they are not, the public are paying for quack nostrums, and the people who assist the sellers of these things by paragraphs and the admission of advertisements are quite as bad as the sellers. The consensus of scientific opinion is that the vast majority, at any rate, of these magnetic and electrical appliances are useless, if not injurious, and some protection should be afforded to the public by those who profess to be its teachers. What confidence can we have in the political prophet who runs his paper to a large extent by puffing electrical pills? Another feature of this disgraceful state of things is that the advertisements of many of these nostrums are set up in the paper as articles or reports, and mingled with the ordinary reading matter. What a sign of the times! We have lost the bluntness of speaking of our ancestors—we mince our words and methods, are effeminate and foppish, and permit the most gigantic swindles to be perpetrated in our midst because somebody thereby makes money. Our forefathers would tell us we are a lot of hypocrites—with an adjective.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ACCUMULATOR TRACTION.

SIR,—Referring to your able leader, "Hay *v.* Electricity," in last week's *Electrical Engineer*, in which you point to the very propitious time for the increased activity of all those engaged in electric traction enterprise, we gladly acknowledge your evident object to draw attention to the many great advantages of accumulator traction which have no doubt been attained. But why consign every hope of a successful cell for this purpose to the future when facts indisputable and convincing are easily available, demonstrating that batteries possessing all the qualities essential for traction work are supplied by this company, and have now been in use in Birmingham for over 10 months?

The reproach of keeping results dark touches us not, for we have from time to time published particulars of the working of the Birmingham Central Tramway Company's Bristol-road line, and the behaviour of our cells used thereon—statements for the absolute accuracy of which we can adduce the best proofs in the records of the tramway company. These are briefly summarised thus: 1. That the Epstein cells have been in continual use on the Birmingham Central Tramways since August, 1892. 2. That the service kept up since that time has been conspicuously free from stoppages. 3. That these cells have never given the slightest trouble, notwithstanding that during the winter months they were taxed to the utmost. 4. That the batteries now in use and still doing good service have each completed between 4,000 and 6,000 car miles without so much as a single plate having to be renewed or doctored, results never before approached. 5. That the rate of 1½d. per car mile at which we have undertaken to maintain our cells over a period of seven years, and to renew all such parts as may in time fall below a certain capacity, is considered very advantageous by the tramway company, while being remunerative to us.

On every single point in connection with the working of our cells at Birmingham, highly satisfactory information, backed by documentary evidence, can be given, which must carry weight and convince anyone who has not made up his mind to ignore all contemporaneous achievements. The service of the line on which our accumulators are in use is to our knowledge more regular and reliable than that of any line operated on the overhead wire or on the conduit system, and it can be proved that such a line can be more economically worked than any direct-current system. The cells are efficient and of extraordinary durability.

The cost of their maintenance is guaranteed, and the first outlay for installation compares favourably with that for every other mode of propulsion. A few figures will easily demonstrate this. The cost of electrical equipment only, independent of permanent way, rails, etc., is for the overhead system about £4,000 per mile double track, for the conduit system about £6,000 per mile double track.

The outlay for accumulators per car accommodating 52 passengers is covered by £500. Taking as a representative line a tramway, say, six miles long, the electrical equipment would cost: for the overhead system £24,000, for the conduit system £36,000, respectively; or with the same capital expenditure 48 cars, or 72 cars respectively, at £500 per car, could be provided with accumulators. Now, at a speed of six miles per hour, including stoppages, a car would perform the journey in one hour; therefore 48 cars on a double track would provide a 2½-minute service, and 72 cars on a double track would provide a 1⅔-minute service—a frequency of service which will scarcely ever be required, a five-minute service being already considered very quick. Longer time intervals between the cars at once tell in favour of accumulators, reducing the number of cars required, and consequently the capital expenditure.

As regards the complete success of self-contained cars fitted with Epstein accumulators, this is beyond dispute; facts have proved and continue to prove this conclusively.—Yours, etc., L. BROEKMAN, Manager,

The Epstein Electric Accumulator Company, Limited.

June 28th, 1893.

[The above letter seems conclusive as to our surmise that some, if not all, of the prominent makers of accumulators will be able to guarantee results.—ED. *E. E.*]

THE JOINT PARLIAMENTARY COMMITTEE ON ELECTRIC POWERS PROTECTIVE CLAUSES.

THURSDAY.

(*Concluded from page 627.*)

Mr. J. Swinburne, examined by **Mr. Cripps** in the interests of electric traction, considered that the single-wire telephone method was a cheap and bad system, and he attributed all the interference to which telephones were liable to the use of the single wire with earth or water-pipe return. The earth return was rarely used in telegraphs. In one sense it was used in telephony, but, as a matter of fact, nearly all the telephones used the water-pipes as return; earth-plates were adopted where pipes were not readily available. The electric light companies insulated their mains, not because they were told to do so by law, but because they could not get large currents through the earth. With electric tramways the conditions were different; there was either a complete return or a very fair proportion of a complete return provided by the rails. Then the same condition did not obtain in regard to insulation, as the rails could not be simply insulated as in the case of electric lighting, because a contact was required to be made from point to point all along. It therefore necessitated the use of bare conductors with a tramway. The tramways had a natural uninsulated return by the rails, and in large tramways it was necessary to use an additional uninsulated return. There was no analogy between a lighting and a traction company. With the former, the conductor could be covered with insulation, but in the case of the latter it must be bare, so as to get at it with the collector. Moreover, in electric lighting the conductors could be placed in a culvert or pipe and covered completely over. That was, however, impossible with electric tramways, because with an underground system it must be left open for the collector to reach the conductor. An electric light conductor might be covered with insulation or not, and have air insulation. With a tramway on the overhead system there was not so very much difficulty in insulating the second overhead conductor: but there was a difficulty of insulating the conductor in an underground system. The points where the conductor was supported were exposed to damp, mud, snow, and dust, and all those were apt to collect on the porcelain insulators, and finally make a partially conducting bridge across which the electricity could flow to the ground, and it was that great difficulty which had led to the abandoning of the culvert system in America. It was obvious that if drainage could be managed perfectly, water could be prevented from filling the culvert to such an extent that it would touch the wire simply because the culvert was full up to the point where the wires were; but even that difficulty had arisen in America. Even if drained, the damp could not be drained away, and the damp would cause breakdowns. Those things were all matters of degree. From a practical engineering point of view, it was impossible to insulate those things. The single-trolley system, as adopted at Leeds, had been extensively used in the United States, and two years ago there were about 3,000 miles of line operated on that method. It was rapidly displacing horses, and cheaper than horse traction, and somewhat cheaper than cable haulage. The witness believed that the system interfered with the telephones in America as in Leeds, and the solution of the problem was that the authorities, after mature consideration, came to the conclusion that the roads were intended for traction, and not for talking through. Asked as to whether the double-trolley system would be simple as far as insulation was concerned, the witness remarked that it would be difficult—not so difficult as the insulation of a double underground system, but it was very much more difficult than the single-trolley system was as regards insulation. He did not regard a double-trolley system as practicable from a commercial point of view. It was not only the difficulty of insulation, but that of extra complication, and the unsightliness and the great difficulty of managing the collection of a double overhead current. With one fishing-rod overhead to collect from one set of wires, no trouble could be caused overhead by making two opposite poles connected with the dynamo touch; but with two overhead there was considerable difficulty in working two fishing-rods, and in arranging the wire circuits so as not to cause a short circuit. That gave rise to great practical difficulties. The unsightliness of the double-trolley method would prevent its coming into use in a busy town. If adopted anywhere it would be in simple cases and in country districts. The single trolley had been adopted so largely in America that it had practically ousted all other systems, and he thought it was the most practicable. With regard to the Budapest tramway, with its few crossings and turnouts, he did not regard that as any example of what would obtain if anyone tried to put down a complicated urban tramway system with underground conduit and double insulation. When dealing with underground culverts, the branch lines became enormously complicated, and that was where nine-tenths of the difficulty came in, because all the crossings of those wires had to be arranged underground in such a manner that the tramcar could not make any short circuits. He did not think the problem had ever really been solved. The only way it had ever been done had been where power had been supplied available for the car at a certain place. That was all right with a simple system if the tram was going straight along or the streets not crowded, but it would be impossible to work such a method in a city like London. There would not be sufficient momentum upon the car to take the car 10ft or 15ft. The only way, like at Budapest, was to get out and push when stopped in that way. In reference to the Leeds system, the telephones and telegraphs would be perfectly protected if insulated by metallic returns. The insulation of the telephone and railway wire returns would give the best obtainable protection. There was no such thing as perfect insulation or a perfect conductor; but having regard to the insulation of a tramway, it could not be made perfect, and he did not think it would be practically possible to make a tramway system so perfect that there would not be enough leakage to disturb telephones and certain railway signals. There had been no advance in electric traction since the insertion of the protective clauses in various Acts. Difficulty was experienced through both induction and leakage, but the former was the most important cause of the disturbance in connection with tramways. Induction depended upon the relative positions of the conductors compared with the position of the telephone, and the position was set out by the exigencies of the case. In running a dynamo the conductors had to be put in a certain position—they could not be twisted to get over the induction, whereas the telephone company could use a double return and twist it. One system or the other had to be twisted to prevent the induction, but with traction that could not be done. It would be an easy matter for the telephone company to overcome the difficulty of induction by twisting, as was the usual way in which it was done, and the cost was practically no more than that of putting up the return in the ordinary way. With regard to Lord Kelvin's statement, that by making certain alterations in the trolley contacts the difficulty might to a certain extent be met, the witness observed that he had made experiments at Leeds to find out whether that was so or not. A long flexible wire was taken from the car to the overhead conductor so as to cut out and entirely dispense with the trolley wire; another long flexible wire was taken to the rails from the other end of the motor, so that the current did not have to pass to the wheels in running that motor backwards and forwards, and then there was no appreciable difference in the telephones. The witness had entirely eliminated the cause of disturbance suggested by Lord Kelvin, and found that the disturbance was apparently as bad as before. He had not prepared an estimate, but he did not consider that the cost of metallic telephone circuits would be great. It would not be necessary to metallically connect all the *wires.* It would not be sufficient to double the disturbed wires *only, but it would be* infinitely more efficient than by using them with an earth return. The erection of complete metallic circuits would obviate the disturbance caused by tramways, and he did not consider it would be necessary to alter the switchboards in order to carry out an insulated return system. In the case of railway signalling the witness thought that one return would be sufficient for a number of signal wires. There was no doubt, apart from the question of electric traction, that the telephone company would be obliged to adopt a metallic system. There would doubtless soon be many competing companies, and the first company (the New Telephone) which proposed to compete intended to use metallic returns, and other companies would also adopt metallic circuits. He opined that in a comparatively few years metallic returns would be used in most towns; they must be installed in large towns and cities. If electric lighting and traction companies developed at all, the witness thought that the railway companies would also have to introduce metallic returns. That would be necessary, apart from traction interests, because of the electric light companies. He thought either large electrical industries must not develop, or railway companies would have to protect themselves by using return wires or some other form of protection. At Bournemouth, where he had investigated the matter on behalf of the telephone company, he found that the disturbance in the wires was caused by the electric light company using alternating currents. He could hear the hum of the electric light company, and the disturbance was annoying. There was disturbance, although both the light and the telephone systems were comparatively small systems.

By **Mr. Pember**: The practice in telephony was to take the return to the water-pipe in the house, and that was in metallic connection with the water-pipes in the ground. A portion of the current passed into the ground, but most of it went through the pipes. It was necessary, with a slot system, to insulate the first conductor. The insulation of the second conductor doubled the difficulty, and in case of disturbance it did more than that. If one conductor was well insulated and the other conductor connected to earth and something went wrong, say a short circuit, the insulated conductor would go to earth; a local current was then merely caused across the point where the fault occurred, and if an attempt was made to do without insulated conductors, one might break down. Supposing one did break down in one place first, if nothing happened, it would not be detected; another breakdown somewhere else, then the whole E.M.F. of the station would be sending an earth current across from one point to the other across the country, and that was a much more serious thing than the leakage due to the few volts ordinarily expended in the uninsulated return circuit. There was no greater difficulty in insulating one conductor than the other; but to insulate the two the whole difficulty was increased. It was not simply multiplying by two, but the difficulty was increased very largely, and also in the motor. Two wires, for instance, had to be taken down the plough instead of one, and it was more difficult to do that than to take one down. The witness believed the single-trolley system was cheaper than cable haulage. He suggested, in the choice of a system, that in a place like London reference should be had, not only to the systems now in use, but also to those which might be introduced in the next few years Engineers were experimenting with systems which did not require the use of overhead wires or culverts. The arrangement proposed was to use a closed-conduit system, the working of which the witness explained. Such a system must be open to the earth on the ground surface, and it was possible that that method might be the only system that could be used in London. It was possible in the future that the only system available for tramways in London might be required to be connected to the earth at certain points. The system had not been commercially applied, but it soon might be. Asked as to the method he would recommend in case that system did not come into working order, he deposed in favour of the overhead single trolley for London. It was the least objectionable method. It meant at present, as far as a large portion of the metropolis was concerned, that electric traction could not be had until inventions in the applications of electricity were more advanced. The witness did not think that the protective clauses had in London been the cause of the stoppage of electric tramways, but he thought they had helped, though not in the busy parts. He would introduce the overhead system wherever the people would submit to it. It was a question simply of alleged beauty of the streets against practical convenience. The overhead system had been adopted in many American towns which were more beautiful and busier than Manchester or Liverpool. As far as he could see, the underground system, as at Budapest, was much better than the overhead method as far as sightliness was concerned. By providing two collectors in the case of Budapest, where the telephones were disturbed, the difficulty of the gaps might be overcome, but in surmounting it other difficulties would be introduced. The witness believed that the objection to overhead wires had been one of the objections that prevented the introduction of electric tramways in England. It was true that there were about 100 miles of line at Cincinnati operated on the double-trolley system, but that mileage was nothing in America. With regard to putting the two conductors close together to overcome induction, the witness said it could be overcome in a degree, but he did not think two wires could be placed close enough to be safe to prevent disturbance in telephones in a complicated case. Telephone wires were often a long way distant from the disturbing cause. Water-pipes were frequently laid along the street, and if telephone wires were connected to the water-pipes there might be inductive disturbance, simply communicated by the tramway to the water-pipes. That was, he thought, in many cases the chief disturbance to the telephone, as it was communicated to the water-pipe.

By **Mr. Pope**, on behalf of the gas and water companies: As to electrolytic action, if large currents were permitted to pass along gas-mains, and if the main was allowed to form the positive pole, the gas-pipes could be eaten away. The witness considered it fair that the gas companies should be protected from having their gas-pipes eaten by their electrical rivals, but it did not necessarily follow that in a grounded return of the tramways the gas or water pipes should be eaten away. It was not the least likely if a properly arranged system was used. If the grounded return—that is, not a return by earth but by an uninsulated conductor—was adopted, he did not think there was any real chance of the gas-mains being eaten.

By **Mr. Cripps**: Electrolytic action in the case of tramways could be provided against. The simplest way was to have ground returns, a naked conductor; and in spite of the clause protecting gas companies, he would like to connect the gas company to the negative pole of his dynamo. If there was any electrolysis due to escaping currents, it was only a small percentage which would attack the gas-pipes. The result was that in order to wear out the gas-pipes, a number of circuit rails would have to be worn out. Electrolysis would be an infinitely more serious thing to traction systems. They would, therefore, arrange so that there would be comparatively no waste on their own side, therefore there would be no damage done to any pipes.

Mr. R. E. Crompton, called by **Mr. Graham**, said that the protective clauses like the Wellingborough clause had prevented the spread of electric traction. There was absolute proof of that. His firm, in common with others, were asked by the Glasgow Corporation to accept the responsibility of complying with the protective clause introduced into that Corporation's provisional order, and they found themselves utterly unable to take that responsibility on their shoulders. That was the Plymouth clause. As an engineer and contractor anxious to secure the order, he had spent a long time in trying to find out if by any expenditure or ingenuity of their staff they could devise means to so arrange the plant as not to affect the telephone lines. He was reluctantly compelled to write to the Glasgow Corporation that he could not take the responsibility. The witness had considered the question as to whether many thousand of pounds would accomplish the object, but he found there were no known methods that had worked satisfactorily of doing what the company were asked to do in that clause He found that it was practically impossible to insulate to the extent to make it quite certain that they would not interfere with the telephones. He had not considered overhead double conductors, but he thought they would be insupportable in this country. Single overhead conductors had been greatly objected to by local authorities in this country, but any attempt to introduce a double overhead system was utterly a waste of time, and would never be permitted. He had, therefore, confined his attention to the perfection of a system of underground double-insulated conductors, and on which he had been at work for four or five years; but he had not been able to introduce those patents into any complicated system of lines. The crossings and turnouts no doubt at first seemed easy, but when the details were considered the difficulty of dealing with two insulated conductors was practically insurmountable. For instance, there would be a number of blanks at places where one of the conductors was stopped off, and the cars would be without propelling power with this blank in a dense traffic. He had been to Budapest and inspected the electric tramway. It had been constructed regardless of expense, and he noticed the difficulties of the blanks. Whenever two cars were stopped, one after the other, the second car had to be shouldered over the crossing. He thought that a slot system would probably be the system to be used in the future, but not such a slot as at Budapest, which was entirely impossible in England on account of the width of the slot. The wheel of a hansom cab would go in it. He thought that a narrow slot system could be arranged for a single insulated conductor. It had not yet been successfully accomplished, but it might be done. There were no great difficulties in the way, but the rails must be left as the return conductor, insulated as far as they could be by the road itself; but the rails could not be insulated under all conditions, and therefore if only part of them was insulated, one might as well leave off attempting to insulate. About 5 per cent. of the current produced by the dynamo might pass through the earth back to the dynamo; only a microscopic quantity, he thought, would pass along the gas-pipes. The question of electrolysis due to leakage from continuous currents had been much exaggerated. He had tried every possible means for several years in London to find whether the damage which was said would be done by electric lighting had been done, but he had never yet traced a case to the electric current, provided proper precautions had been taken at the generating station to connect the proper pole of the generating system to the earth. Under the Board of Trade rules, electric lighting companies were not permitted to connect any pole to the earth, but on account of a great number of the conductors of electric light stations being in private houses, and that there was always leakage in the houses, it was pretty easy to arrange that the bulk of the leakage was on one side of the system, so that the negative pole of the system was got nearest to the earth's potential. Where that was carried out, there was no attacking of the metallic pipes whatever. He believed all the cases reported, and which were very few, had been due to the current at the time when the other pole had been at earth's potential. Under such circumstances accidents took place. As a rule, the insulation of the electric light mains suffered so greatly that there was immediately a heavy leak, and before there was time to cause much damage by electrolytic action it was discovered; some damage might be done then. That had only been discovered by actual practice two or three years ago, and since being discovered there was no longer any further trouble. Of the many miles of main under his charge in London, he had been unable to identify any serious action that could be said to be in excess of what occurred before electricity was used as it was at present. The conditions between electric lighting and traction were so different that they could not be compared Electric light companies could show that their mains were practically tied, and that the leakage was so infinitesimal as not to be considered. Such leakage as had occurred through electric light circuits had been small, and had been put up with by the telephone company. The witness considered that in the future telephone companies, in their own interests, would be obliged to have a complete metallic return. In the case of fair competition, as stated by Mr. Swinburne, the telephone companies would be compelled to put in metallic returns. He believed that it was the immunity from competition which enabled the telephone company to use the earth return.

By **Mr. Pember**: The Southend tramway, which he had constructed, was most successful, and had paid its capital twice over. It was more a railway than a tramway. With regard to the contract for the Glasgow electric cars, he had been asked to tender for the cost of the line. He did tender, but wrote stating that he could not undertake the responsibility of the protective clause in the specification, and in which he would have to take over the responsibility of not interfering with the telephones. He had seen the estimates prepared by Dr. E. Hopkinson, but had not studied them; they did not provide for contingencies which were absolutely necessary.

Friday.

Mr. R. E. Crompton, whose cross-examination was resumed by **Mr. Moulton**, said in regard to the blanks in the Budapest system, that if a car stopped at those places it would have to be pushed on. That difficulty could be overcome by adopting a double system of ploughs, but that would be all complication. To surmount the difficulties of sparking, it had sometimes been considered advisable to have two collectors, so that one passed over an insulated point and jumped, a spark being avoided on account of the other collector being down at the same time. Double ploughs had been tried, but there was extra complication, even when the ploughs were at the same potential, and the advantages expected by their use had not yet been found. He had used them, but was better without them. That method was not at present used at Southend, and had not since the beginning of the year.

By **Mr. Graham**: The previous day he had been asked whether the system that was being adopted by Messrs. Mather and Platt in the Isle of Man could not be used. He thought he ought to have said in reply that one reason, as he understood the proposition, was that it involved doubling the electrical pressure, and that was a condition of things which would not be permitted by the Board of Trade. With regard to two conductors in a conduit, the difficulties of insulating two as compared with one were increased something like four, five, or tenfold. The large culvert, although possible at Budapest, where there were not many underground pipes, was absolutely out of question in English cities such as London, Manchester, and Liverpool, and it was only idle talk to speak of the Budapest system being a possible method for use in England. It could not be carried out even if desired, and the space required to get the safety obtained in Budapest was not obtainable in this country.

By the **Committee**: The traffic in London was different to that of Budapest, and owing to the large quantities of mains, etc., it would be impossible to work the system. Electric car-starters could be provided at additional expense, but it complicated the system. Mechanical car-starters had not been a success. As regarded the expenditure of putting down the Budapest system, taking a street near King's Cross, it would cost about £10,000 or £11,000 a mile.

Mr. A. R. Bennett, who had received an order from the House of Lords to appear and give evidence, said that he would not have voluntarily done so. At present he was general manager and chief engineer to the New Telephone Company. A metallic circuit exchange, if designed from the beginning exclusively for metallic circuits, and without the intention of putting up single wires in the ordinary way, would not cost appreciably more than a single-wire exchange with single overhead wires. With metallic circuits, many wires could be placed close together without interference with an efficient service, so that the wires could be put in a cable, and a great many maintained in a small diameter. The open wires used in a single system had to be strung up on supports, each wire being kept at a distance which should not be less than 8in. or 9in. apart, and preferably 12in. Therefore the space occupied by the single-wire method was necessarily much greater than if the wires were put in a cable. It was possible for a short distance to put the single wires in a cable, but there were practical difficulties in the way which were seriously against it. Induction was greatly augmented, so that except on short lengths overhearing was greater with the single wires in a cable than if suspended overhead. Telephony could only be efficient and satisfactory by adopting a metallic system; and a change from the single to a double system could be carried out with great care without altering the switchboards, and the metallic system would not be brought into use until complete, or when it replaced an equal number of single-wire circuits. The conversion to the metallic system would obviate all difficulties due to electric traction, and all interference from other sources. It would be possible instead of doubling each wire to use a return for several wires, but it would not be such a complete cure as entire duplication. If asked to erect a new exchange, the witness would advocate metallic circuits. All sources of disturbance, whether from earth, electric light, traction, or telegraph currents, etc., would be entirely got rid of by metallic circuits. Apart from traction interests, he would recommend telephone companies to use complete metallic circuits, and by so doing the number of subscribers would naturally increase. The most perfect protection for railway companies was the absolute duplication of the single wires, but disturbances might also be prevented in two other ways. In the first case a common return wire, or, to avoid possible accidents, two separate return wires joined together, might be used for a considerable number of railway instruments. The other plan would be to run a wire from the railway station or cabin where the disturbances occurred a certain distance back, and there put it to earth. It would be very difficult, from a traction point of view, to deal with conduction and induction so as not to affect the telephone system if the traction interests said the earth return was necessary to them.

Mr. Alex. Siemens, examined by **Mr. Cripps**, gave, as the basis of his evidence, particulars of his own and firm's experience in the different establishments in the world. Asked as to whether block instruments should be insulated by metallic circuit return, he said that as a matter of fact those signals were almost always guarded against single impulse currents. If induction was also to be obviated, all the wires must be doubled. The general tendency was to dispense with overhead wires and put them underground, and if placed there they must be metallic. The Budapest tramway system would cost at least 50 per cent. more if used in England.

By **Mr. Wallace**: The Budapest system was a practical success. There were about 60 motor cars and 15 miles of line, and extensions were being made. He did not think there was any difficulty in the crossings; the gaps had been left, and means had not been provided to complicate the system. They had left the line as it was, and only used one plough. The line had been worked with perfect satisfaction to everybody, and it probably could be carried out in this country.

By the **Committee**: Apart from traction, block signals were so arranged that they could not be moved by currents produced by traction. Questioned as to whether he would recommend the Budapest system in this country, the witness said that it was extremely expensive. An ordinary tramway cost about £3,000 per mile, with overhead wires £4,000, and the Budapest would cost about £6,000, provided there were no obstacles. His firm had tried to introduce the Budapest system at Bradford, but owing to some bridges it was impossible to construct a tramway on that system. He was of opinion that in all large towns it would be practically impossible to introduce it.

Mr. J. H. Greathead, called by **Mr. Graham**, put in figures showing the growth of passenger traffic in London during many years past. He did not consider the present facilities adequate for bringing in and taking out the population of London. As chief engineer to the City and South London Railway he knew there had been no complaints of interference with the telephones. It was possible in an underground railway to place the rails on wooden sleepers, which would insulate them to a certain extent. There were gaps on that line, principally at the stations, but they were bridged over by pieces of copper.

By **Mr. Pember**: The City and South London line had since constructed accepted the Plymouth protective clause. The City and Waterloo, the Paddington and Clapham Junction, the Central London, and the Hampstead and St. Pancras Railways had also agreed to the clause.

By **Mr. Graham**: The estimated cost of the conductor in the case of the Central London Railway was £75,000, and if it was suggested that an absolutely insulated return should be imposed upon the company it would involve additional expense Moreover, the working expenses at the generating station would be increased by 15 per cent., and altogether it would result in an increased cost to the company of £40,000 per mile, or £240,000 for the six miles, and the gain would be very trifling indeed. The very small difference of pressure between one end of the City and South London Railway and the other end would leave little chance of any action on pipes outside the lines.

By **Mr. Pember**: In the case of the Clapham Junction and Paddington, although the company had offered to use an insulated return, the South Kensington authorities objected to the line being brought there because they thought there would be induction and so disturb the instruments.

By the **Committee**: Asked whether there had been any disturbance in the telephones and telegraphs through the working of the South London Railway, the witness said that in 1891 Mr. Preece thought there was more interference than he liked The company had carried out certain alterations which seemed to satisfy the Post Office, and he had not heard that Mr. Preece had complained since then. With regard to the ringing of the bell at the chemist's shop in Clapham-road, the witness had visited the shop the previous evening. From measurements then made he came to the conclusion that there was a difference of potential between the gas and water pipes of about one-tenth of a volt. That was barely sufficient to ring a delicately-arranged bell at the shop. He and others also made tests between the gas and water pipes at the several stations on the railway, and they were unable to detect any difference of potential between them. He believed that a current of one-tenth of a volt would not have any electrolytic action. No complaints had been made at Liverpool as to disturbances in the telephones and telegraphs there. The cost of the Liverpool line was £85,000 per mile, and the signals on it were automatically worked and were not interfered with by the traction current. Similarly, on the South London line the telegraphs, telephones, and signals there used were not disturbed.

Mr. F. Jennings Parsons, examined by **Mr. Cripps**, stated that he was chief engineer to the Thomson-Houston Company in *Paris, and had just* returned from the United States. The double *overhead system had been* used for some years at Cincinnati, and was working satisfactorily as far as it went; but it was not satisfactory, from the fact that it cost very much more to instal and maintain, and therefore all extensions that were made—and extensions were always being carried out—were on the single-trolley system. His company had approximately 5,000 miles of electric tramway in operation. The earth return with central conductor was practically universal in America. The telephone companies in Cincinnati had been obliged to get out of the difficulty of disturbances the best way they could, and in large cities those companies were duplicating their wires; in small towns a single return was used for a group of wires. The question of electrolytic action had occurred, and they were remedying that by putting down a heavier return wire.

By the **Committee**: At Boston the current was collected from overhead, and the return was formed by the rails, between which a copper return was laid. The latter was an addition to overcome electrolytic action. The voltage used was 500 volts.

Mr. S. Sellon, examined by **Mr. Graham**, exhibited a model representing the double-trolley system as used at Cincinnati. He had had proof of the restrictions caused by the protective clauses, being connected with the Thomson-Houston Company of America. They had tried to do a large business in England, and up to the present, except where those clauses did not apply, they had done nothing. They had been compelled, owing to those clauses, to refuse to carry out an electric tramway system in Glasgow and at Yarmouth. The witness did not think it possible, except at great expense, to insulate underground conductors on tramways so as not to interfere with telephones. He gave figures as to the growth of electric traction in the United States.

By **Mr. Pember**: The clause in the Glasgow specification would have made his company responsible for affecting the telephones through leakage after the tramway had been constructed, and they could not undertake to indemnify the Corporation in that event.

By **Mr. Worsley Taylor**: He was not aware that the capital expended on tramways in the United Kingdom amounted to £15,500,000, or that 500,000,000 passengers were carried by them annually. The corporations were endeavouring to get the tramways in their possession, and were seeking to work them by application to Parliament. With electric traction it would be possible to reduce considerably the cost of traction. The average cost of horse or steam traction was about 8d. per car mile; with electric traction the cost was about 5½d. or 6d. At Leeds the cost with horses was 7·77d., and the electric tramway there was working at 5½d. Steam-cars were greatly objected to by local authorities, and were rapidly dying out, and it would be absolutely necessary in future to have some system to replace steam, because with heavy gradients some kind of mechanical power was required. At Boston, since the adoption of electric traction, there was 47 per cent. more traffic dealt with than was originally carried by horse cars.

Major-General Webber, called by **Mr. Cripps**, expressed the opinion from his experience that metallic circuits were indispensable to ensure an efficient telephonic service, and that where the number of wires exceeded seven or eight they should be placed underground.

Mr. Heskit, examined by **Mr. W. Taylor**, stated that he was electrical engineer to the Blackpool Corporation, and general manager of the tramways. The electric tramway there, which was two miles long, had been in operation for eight years. During the past month it had been necessary to break up the streets to lay down electric light conduits, and in no case did he find any evidence of electrolytic action on the gas and water pipes. The return for the current on that line was formed by the rails, which were connected together so that there might be a more ready path. He had made frequent tests and had found that the interference of the tramway was not so great as the disturbance caused by cross-talk in the telephones. The electric tramway there was about to be modified, so that the slot should only be open at any points covered by the cars at any time, as the sea-water had caused considerable difficulty. The central conduit would be used as return, and an auxiliary copper conductor laid beside it, so that there would not be at any time a greater difference of potential than 1½ volts. It was not necessary for tramways to use an insulated return, and he would protest against it; the difficulties at the crossings and turnouts were very great, and especially in a conduit system.

By **Mr. Pope**: The Blackpool Corporation had promoted a provisional order, and a portion of the new lines was to be leased for working by accumulators, which would not interfere with the telephones.

Mr. J. B. Cooper (town clerk of Walsall), in examination by **Mr. B. Browne**, detailed the tramway system there, the action of the town in regard to the electric tramway, and the sending to the United States of a local engineer to investigate the conditions of tramway working. Since the beginning of the year, when the operation of the tramways by electricity was first commenced, the tramways had worked highly satisfactorily, and both the Corporation and the public were pleased with them The service had been improved, and down to the end of May 1,095,000 passengers had been carried. If necessary, the Corporation would rather dispense with the telephones than with the tramways. There had been a slight disturbance in the telephones—a certain amount of roaring—but not sufficient to prevent conversation.

Mr. Young (general manager of the Glasgow Corporation tramways), questioned by **Mr. W. Taylor**, said there were 30 miles of line there, constructed at a cost of £345,000. Last September the Corporation advertised for tenders for equipping the tramways by electricity, and in the specification a condition was inserted that any firm who tendered should be responsible for any indemnity within the meaning of the protective clause contained in the Corporation's Act. Eleven offers were received, as follow: Crompton and Co., Easton and Anderson, the Electric Construction Corporation, Dick, Kerr, and Co., the National Electric Company, the Westinghouse Electric Company, Greenwood and Batley, the General Electric Power and Traction Company, Siemens Bros., Woodhouse and Rawson, and the Thomson-Houston International Electric Company. Not one of those firms would accept the responsibility of the protective clause.

By **Mr. Pember**: Some five or six of the firms wrote and refused to take the responsibility; the others ignored it altogether. The Glasgow Corporation had only accepted the clause under the pressure of the National Telephone Company.

By the **Committee**: When the clause was accepted, the Corporation did not think so much of adopting electricity as afterwards.

Mr. J. Ward (mayor of Leeds), in reply to **Mr. B. Browne**, deposed that in Leeds there were 22 miles of tramway worked by steam and horse cars and about three miles operated by electricity. The Corporation, in its Consolidated Bill this year, had endeavoured to secure powers to use electricity generally, but owing to the protective clause the Bill had been withdrawn. The experience of the Corporation with regard to electric traction was very satisfactory, and there were no lines in operation in Leeds that were so popular as those worked by electricity. He thought the feeling of the Highways Committee, of which he was a member, was that they would like to dispense with the steam-cars. The opinion of that committee and the great majority of the members of the Corporation was greatly in favour of electric traction, and their feeling was that no clause should be inserted in the abovementioned Bill which would prevent their using electric traction.

By **Mr. Pember**: The Corporation hoped to arrive at electric traction without the use of overhead wires. It did not matter in the suburbs.

By the **Committee**: He believed the Corporation was virtually asked to accept the Plymouth clause, but they could not do so. They did not wish to damage the telephone company.

Mr. Keevney (mayor of Salford), examined by **Mr. Taylor**, said that in Salford there were 13 miles of single line, which formed part of a very large system extending to Manchester and elsewhere. The tramways in Salford were at present leased, but the lease would expire in five or six years. This year the Corporation introduced a Bill for the purpose of doubling a part of the tram lines. The National Telephone Company opposed the Bill, and most unjustly too. That company asked not only that the protective clause should apply to the small portion to be reconstructed, but also to the whole system. At that time the Corporation had in view electric power for the whole system, but owing to the protection desired by the telephone company the Bill was withdrawn this session. The Corporation would, however, proceed with the Bill another time, and would not permit the clause to be inserted.

Mr. J. Southern (member of the Manchester Town Council), examined by **Mr. B. Browne**, said that the Corporation exercised control over the streets. The Corporation owned 30 miles of tramway, and that was coupled up with the systems of Salford, Oldham, etc. He would deprecate any steps to debar them from using electric power.

MONDAY.

Major P. Cardew (electrical adviser to the Board of Trade) who was called by the committee, said that he appeared as an independent witness. He desired to correct a statement made by Sir Courtenay Boyle with regard to the gas-pipes at Preston, the latter having attributed the damage done to them to electrolytic action. The witness, however, attributed it to the passage of an electric current between the iron culvert in which the mains were contained and the service pipes that were damaged. He produced specimens of pipes that had been acted upon by the current. In one case the destruction of the pipe was due to the imperfect condition of the mains of the Preston Electric Light Company, resulting in the formation of an arc. In another, 3in. of a service pipe had been melted where it came into contact with the electric light culvert, whilst in a third case a large piece had been melted out where the service pipe was touching the underneath of the culvert. In these cases the damage was not caused by electrolytic action, but something quicker—that was heat. The sandy soil, he thought, intensified the accident at Preston.

By **Mr. Forwood**: The mains were laid in an iron culvert, and the gas-pipes were either absolutely in contact or nearly so. The accidents were due to faulty insulation.

By **Lord Russell**: He did not think it possible to prevent accidents, although he thought that the likelihood of serious accidents might be greatly diminished by proper precautions. Under the circumstances, he thought that sufficient care had not been taken by the Preston Electric Light Company before the accidents happened, and the accident might be attributed to carelessness. If the system had been carried out exactly as detailed and specified by the contractors, and if all reasonable care had been taken and proper tests made, he was quite certain that those accidents would not have occurred. By laying such a form of culvert containing bare strips of copper conductors, although insulated, it was an error of judgment to allow gas-pipes to come into contact with the culverts; and that was perhaps due to the hurried way in which the electric light installation had been carried out.

By **Sir B. Samuelson**: There had been several cases of damage to water-pipes, and also to a gas-meter. By tests which he carried out on the last occasion that the water-pipe failed, and the locality of which he did not disclose, he had proved that the damage was caused by the mains of the lighting company, and was due to electrolytic action. He had a specimen of the pipe, which was much corroded, but he would not say that the whole of it was due to electrolytic action. The difference of potential between the electric culvert, which was of the same character as that at Preston, and that pipe or similar pipe was six volts; that was sufficient to account for considerable electrolytic action. The same current that had been flowing to earth and causing the corrosion had also caused corrosion on the positive side of the circuit. With regard to the metallic connection between the negative terminal of the dynamo and the water-mains in the case of tramways, that method had been adopted at the suggestion of the witness at Leeds and in one or two other cases. On considering the conditions of the Leeds line, where the current returned by uninsulated rails, and that there was water in gas-pipes in the immediate neighbourhood, he had considered it most essential that the tramway company should take all reasonable precautions to prevent damage to those pipes. He had therefore suggested the connection of the negative terminal of the dynamo to the water-main, the result of that being to raise the whole of the electric circuit positive in regard to the water-mains and the general earth. When that was the case, any leakage of current passing between the electric system and the water-pipes would tend to corrode the rails, and would tend to preserve the water-pipes. That connection had been made one and a half years ago, and not having felt absolutely satisfied, he, a year ago, examined the Leeds line. As he had anticipated, the potential was everywhere positive to the water-pipes, and amounted to about two volts at the extreme end; he could not find any signs of damage either in gas or water pipes.

By **Mr. Molloy**: The accident at Preston could certainly have been prevented. The imperfect means of localising and testing was the cause of the fault remaining undiscovered so long.

By **Lord Russell**: In the case of tramways, electrolytic action could be confined to the tramway rails.

By **Viscount Cross** (chairman): At the request of the witness, tests had very recently been made on the South London Electric Railway, and the main result showed a maximum difference of potential between the company's system and the gas and water pipes of 2½ volts, except at one station, where it was about four volts between the gas-pipes and the negative terminal. Upon that, he had suggested that a metallic connection at that point between the rails and the gas-pipes might be found. That was soon discovered, and he thought that that had been the cause of the ringing of the bell to which reference had been made. With regard to electric tramways, improvements could be made, and very probably interference even with existing systems of working could be avoided. It was impossible to absolutely avoid any interference between any two circuits on the earth, but practical interference was a very different thing. In the case of the South London Railway, tests made last week had given much information as to where the leakage occurred, and he had no doubt that that leakage could be enormously diminished, and in the case of such railways all practical interference could be avoided. First of all, the whole conductivity of the rails must be utilised, and the second point was to provide a decent amount of insulation between the rails and the iron tunnel, such as teak sleepers. In the case of tramways, the conditions were different, but he thought that there, again, advantage should be taken of the whole conductivity of the rails, to increase the conductivity by an additional conductor in the return circuit, and adapt it, as far as could be, to the system which was used in electric light supply, and to maintain a practically uniform pressure throughout. As regards the causes of disturbance, a constant unvarying current would not affect telephones, however large it might be, or however much the current was escaping to the earth; but in a tramway the current was always varying. There was sudden variation in the car itself, sudden variation caused by sparking at the contacts and brushes, by vibration, and the way in which the armature was wound. The witness had no doubt that improvements would be continually carried out, and he certainly thought that some such improvements in the direction he had indicated were possible. Such improvements were practicable, and would not necessitate any great expense. He attributed the greatest importance to a system of testing the line.

By **Mr. Molloy**: Asked whether with large extensions of tramways and with small amount of leakage any danger to gas or water pipes might be expected, the witness said he did not think there would be with proper precautions and tests. With suitable regulations, such as he had pointed out, there would be no danger of electrolytic action to be apprehended.

By **Lord Clifford**: The action of the tramway at Leeds was rather to damage the rails. Interference with telephones might be caused without leakage to earth; it was due to a rapidly varying current, and what would cure the one would not cure the other. The difficulty would be overcome without resorting to an absolutely insulated tramway system.

By **Major Darwin**: The Board of Trade had given preliminary consent, with certain provisions, to an increase in the working pressure of the Leeds tramway to 500 volts.

By the **Chairman**: The witness thought the overhead telephone wires in London had reached their limit. He would only recommend the connection of the negative pole of the dynamo to the water-pipes, not to the gas-pipes also. Asked whether that would leave them in the same position as at present, he stated he thought not, because with a connection on two water-mains of large section the potential of the system throughout was established practically constant, that was the lowest point—namely, the potential of the earth—and then both gas and water pipes would be protected. A place should not be selected for the connection where the gas-pipe was too close. That connection must be carefully watched, for it was just where it was made that any danger that might result would be shown. For instance, a difference of potential might produced between the gas and water pipes there so as to cause electrolytic action between them, but that could be avoided with reasonable care.

Sir Frederick Bramwell, examined by **Mr. Pope**, regarded electrolytic action as a real danger when certain conditions prevailed. He meant electric lighting and traction where there was not proper insulation of the current from the earth. The condition in the case of the Leeds line was a danger, and if there were no means of protecting the tramway from using the earth that would be a real danger. The proposal of Major Cardew did not take into consideration that there might nct be continuous water-pipes; they might go up another street. Then the water-pipes might have and did have joints which were impermeable by electricity; and the joints of most were coated with a composition which would not give good conduction. He considered that method dangerous, and that it should not be allowed. The proper insulation of the outgoing and incoming conductor would ensure there being no leakage except when an accident happened. Electrolytic action might continue for a year, and the harm to gas-pipes would depend upon the time and the extent of the leakage. A double-trolley system would not be permitted in London, and he considered that slot systems were practicable, as instanced by rope tramways.

By **Mr. Taylor**: He had not discovered any damage that might have been caused by electrolytic action at Leeds. The injury was covered up, and might not be found until there was a rupture.

Dr. J. Hopkinson, called by **Mr. Danckwerts**, said that it was only comparatively recently that he had realised how serious were the effects of electrolytic action on pipes. His view was that the only protection for pipes was to insulate the whole system of electric tramway conductors. He knew there was danger from theoretical considerations, and he showed a gas-meter having two holes in it, and which had been damaged through an earth contact of one of the conductors of the St. James's and Pall Mall Company. The witness showed diagrams to illustrate his impression that oxidation would occur through connecting the water-pipes to the negative pole of the dynamo. He agreed with Sir Frederick Bramwell that there was not perfect conductivity in the pipes on account of the joints, one of which he exhibited.

Prof. Dewar referred to a case of electrolytic action in the United States, and said that the danger was present here as well as there. The remedy was perfect insulation of the return circuit.

By **Mr. Browne**: He had never heard of any other case of electrolysis taking place through leakage from a tramway than the one to which he had referred.

Mr. Foulger, examined by **Mr. Danckwerts**, said he was engineer to the Gaslight and Coke Company, the extent of whose system he gave particulars. There were many accumulatious of gas underground, and he thought protection should be given to the gas company as well as in the interests of the public.

By the **Committee**: There had not been any damage done to the company's pipes by electrolytic action. It was an anticipated danger and a real one.

Mr. L. Epstein, examined by **Mr. Pope**, referred to the use of the Epstein cells on the Birmingham Central Tramways. He produced figures to show that the system was not more costly than the direct system. Renewals cost ¾d. per car mile.

By **Mr. Browne**: The witness said that the Epstein accumulators had been purchased by the tramway company, and that his company had undertaken to maintain them at 1½d. per car mile. If renewed now the cells would cost the company ¾d. per car mile. He was informed by the managing director that the irregularities were fewer than on any other lines in Birmingham.

Mr. Christie (the Astronomer Royal) in reply to the **Chairman**, detailed the disturbances at Greenwich through the working of the City and South London Railway; the current noticed ranged from one-third volt to one-half volt in difference of potential between two eart-hplates. He did not consider the disturbance of sufficient importance to necessitate any restrictions.

TUESDAY.

Mr. Pember, Q.C., in his address on behalf of the National Telephone Company, did not consider it necessary to give an analysis of the scientific evidence. Stated broadly, the question concerned the promotion of electric traction on the one hand and all the electrical world on the other; the lighting companies with their model clauses being apparently content with them. There might in the future be many uses to which small currents could be advantageously put with earth returns. The telephones and telegraphs were of enormous public advantage, and the paper put in by Mr. Gaine, showing hundreds of millions of messages annually, was conclusive of the importance of telephones to the public. From the first the telephone licenses had been worked with earth return, which, with currents such as theirs, was not only natural, but the best and cheapest method. It might be departed from in certain circumstances, but not under ordinary conditions, for, as both Mr. Gaine had Mr. Forbes had stated, when the exchanges were thick and numerous, it was well to have a metallic return Although they recommended and were carrying that out, still 95 per cent of the business was being conducted with earth return. He referred to the low average cost per message, of which 218,000,000 were sent last year, representing three minutes' conversation each way. He would like to know what it would cost to telegraph between two places the words of a person who read aloud for three minutes. Its system could only be altered at very great expense; put roughly by Mr. Gaine and Mr. Forbes at £2,000,000, or about 50 per cent. of the company's capital. That extra expenditure *had to be* considered from the points of view of present business *and as it expanded in future*; and it must necessarily fall upon the public. The license had 18 years to run, and the Crown had still the power to buy up the system either in 1895 or in 1902, whilst in 1911 the license expired. If the Crown did not renew the license, and if the expense was put upon the company, the charge for the telephone to the public would inevitably be increased. It was universally admitted that on the present system underground wires would not do. Was it right, or would it be wise to force the company to the only alternative—the general duplication of its wires and the expense of the insulated return? It must not be forgotten that the telephones and telegraphs were first in the field as users of the earth. The extraordinary high currents used in electric lighting and traction would, if an earth return was used, create such a great disturbance as to render the earth unfit for general use. Such a use would not be a use according to the conditions under which a person could use a common good. That was the principle which underlay the decision of Mr. Kekewich. If the use would prevent its use by anyone else as a common good that could not be done unless assisted by statute, and such statute should not be given. An attempt had been made to turn the position upside down, and to say that it was the telegraphs and telephones, that worked with delicate instruments, that debarred the earth to other people. Parliament had hitherto acted upon what he maintained was the proper principle: it had enforced in 50 cases out of 53 sufficient clauses on electric traction enterprises, and those clauses would be before the committee when the matter was considered. The committee was asked by electric traction promoters to do something new, and which was exactly contradictory to Parliament. It seemed to him that it would be contrary to every principle of logic and justice to turn round and legislate on behalf of those who proposed to bring about the difficulty. Electric traction scarcely existed in England, and he would emphasise that the telegraphs and telephones had the right of consideration which sprung with priority of user. It could hardly be urged that the telephones should have provided against all subsequent user of the currents. The committee had been told that the telephone company was not a parliamentary company; that was not their fault, but the fault of those who granted the license. On two or three occasions the company had endeavoured to bring in a Bill, but the Post Office had always opposed a veto It had been established in the Wandsworth case, when the Local Board instituted a suit to prevent the carrying of overhead wires across the streets, that although the Board was the owner of the streets, and might have some undefined ownership of land, it was limited to that. The company had proved to be working by common-law rights, and not by statute, but were their common-law rights less than if by statute? All agreed that the telegraphs must be protected; they were protected by the Postmaster-General on the part of the nation. As far as he understood, the telephones were gradually cutting out the telegraphs, and it was not too much to suggest that the latter would turn out to be only the forerunner of telephones in this country. It had been suggested that metallic returns were best for telephony. Theoretically, that might be true, but practically it was not so. The results of the more simple method were quite good enough. If they were not, people would use the telegraph instead of the telephones. As Mr. Forbes had shown, in many places the company's subscribers had doubled and trebled, as against the subscribers to the Post Office telephones with double wires. The telephones were far cheaper than the telegraph, and why should the public be deprived of the benefit for a system of electric traction that had not been tried? Had he been allowed to cross-examine Mr. Preece, the counsel would have shown that that gentleman had said in committee that the telephone clause was a fair clause. When the Post Office bought up the telephones it would be at a valuation as a going concern. If Mr. Preece thought that metallic returns were far better, it was of course to his advantage to get the particular article he liked most, and if he could induce the committee to force the company to do it with the latter's money in the meantime, so much the better for him. It was quite clear that the company could only do so by borrowing at high rates, but considering the present tenure it would be impossible to borrow the money. The company for certain portions of their business did see the necessity for metallic returns, and where such was the case they were used. Where was the wisdom of forcing them to adopt them everywhere? There were not 20 miles of electric tramway in Great Britain, against 90,000 miles of telephone wires. Wherever the metallic returns were introduced, the service would be stopped for five or six years. As far as a common return wire for a group of wires was concerned, an accident to that wire would affect the whole group. With regard to the telephone clause affecting electric traction, if that was true, he would still urge its insertion. Here there were two great benefits to the public—the telegraphs and the telephones—and he would say that it was not right to oust one set of undertakers for another, the former being an innocuous user. It was instructive that there were not less than 70 cases where tramway companies or corporations had electrical powers, and which were not subject to any one of the forms of clauses of the telephone company. Had there been no chance of doing any work in any one of those cases? As for cheaper traction, he would undertake to say that there was not one case where there was the least provision for an alteration of fares. Tramways were in many cases monopolists, and it was not likely because they could work cheaper by electric traction that the public would be in the least benefited. In all probability the real reason that had prevented the adoption of electric tramways had been the abominable disfigurement due to the overhead trolley system; Mr. Crompton and Mr. Swinburne had practically admitted it. The traction interests did not mean so much the convenience and advantage of the public, but of the contractors. As far as insulation was concerned, if they could not completely insulate they had better learn, and get rid of the overhead trolley. Electric traction in England would not be permitted until they had dispensed with the overhead trolley. At Glasgow the legal liability was tried to be put upon the contractors, who, naturally knowing that the most perfectly devised system was always liable to accident, declined to accept the proposal. He did not wonder that the contractors would not accept it, or that the Corporation wished to transfer the clause. With regard to the Budapest line, that was a distinct success. The early disfigurement was disposed of and the difficulty of insulation was also got rid of. The tramway worked well and the telephones by it. The difficulty of the crossings could be overcome by the use of two collectors, which would bridge the space. As to Dr. Hopkinson's estimates, no question had been asked of them, and that gentleman had done good traction work. On the other hand, who had done anything with the exception of Mr. Crompton? Science having overcome so many difficulties would not be beaten by mud, nails, damp, etc. As to the insuperable difficulties believed in by so many contractors, as soon as the latter felt that they must overcome them, they would do it. The whole thing was in its infancy, and the present was the time to teach it to form proper habits. Surely the committee would not stand in the way of promoting improvements. He ventured to submit that the action of Parliament had been the right one, and no reason had been shown for a reversal of the course of action. The telephone companies would, of course, be content with a continued insertion of the Plymouth clause in all Tramway Acts. A great number of new interests might in the near future spring up, and it would be wise to safeguard them, on the ground that prevention was better than cure. It might be well to create a general safeguard by enacting that in no case should a current be sent to earth than some ascertained fraction of an ampere. That would naturally cure the effect of the direct current, and also the changing current, but it would not cure induction. Something would have to be done in that way. As an alternative to the Plymouth clause, a provision something like: "It should be a compliance with the requirements of the sub-section if the promoters in the construction and maintenance of their works, and in the working of the tramways, from time to time adopt the best known means of insulating their conductors and other electrical works, and prevent induction with other electric circuits."

Mr. Fletcher Moulton, Q.C., in the interests of the railway companies, said that the task of the electric light companies was far greater than the traction companies. There had been a change of front. The struggle was not over electricity, but one in favour of a rich party, who knew very well that if the committee threw down the obstacles that had kept them out of England, they would be able to extend an imperfect, early, and undeveloped system, which would give more cause and trouble to get rid of as long as it lasted. The indulgence asked by the traction interests was to be allowed to use currents of great intensity and magnitude to use them without taking precautions to prevent leakage to the earth, and to use that leakage as a means of assisting the return current. That would not only put serious responsibility upon others, but it would result in serious damage. The responsibilities of the neighbours would be increased by the great currents running about the earth. Each person had to carry on his business so as not to interfere with that of anybody else. If people were allowed to use an overhead wire as a conductor, and pay no attention to the return conductor, that was a cheap enough system to keep others out. The traction companies had not shown that it was necessary to have the single overhead wire; they had not shown that if that was abandoned there was no leakage of continous currents to the earth. They said, look at America. The whole success, contended the counsel, in America simply meant that it was cheap enough to keep out better systems if it was only allowed. The committee was asked to protect nothing but the single overhead wire system—the crudest and earliest method. Dr. Hopkinson had given evidence that Messrs. Mather and Platt were prepared to carry out the overhead double-trolley system free from all objections, at a price which did not differ by £200 on the whole from the price per mile of the single-trolley system, and that if they were allowed that mode of complete insulation they would be permitted to use double the pressure, about 600 volts; that would come to something like £600 or £700 less than the crudest system. That gentleman had been the first to give attention to the matter, and he spoke with authority not surpassed by any other English engineer. They said it was perfectly practicable at small expense to give protection to their neighbours. The evidence showed that the double-trolley system was practicable, and needed no indulgence such as that indulgence would give: but they objected to overhead wires. There was no satisfactory evidence that if one wire was used in a conduit the use of another would cause any great increase in price. Mr. Siemens had said that the Budapest line was successful, and that blanks had been left because it had not been worth while troubling, but that it was perfectly easy to overcome the difficulties. If the local authorities would not allow overhead wires, the question was as to the use of two wires in a conduit. It was ridiculous that the insuperable difficulty of a 14ft. gap mentioned by Mr. Crompton could influence legislation. The only system that asked for that was the single-trolley method, because the single underground conductor was no more serious trouble or difficulty than the double-trolley system. It was a case where electric traction did not need legislation; it could be done either by accumulators, by the double-trolley system, or underground; but he would say more, there were other systems—closed conduit—that would have a chance if the cheap and nasty was not allowed. Coming to consider the railway wires and the working by current now of instruments themselves or the checks to prevent accidents, counsel said that the objection to the traction disturbance was that it was very violent for a short distance. Now the block wires for the instruments were carried only for a short distance, and would not be under the influence of earth currents, unless owing to severe magnetic storms. It was not denied in regard to disturbances in signal wires that the railway companies would be interfered with if they did not take steps. Could they so protect themselves, though at small cost, so that those people should be allowed that indulgence? Why should any of the cost be thrown upon the railways? The traction companies, to lessen their cost, wished to put it on the railways. Why should that be? The railways said that they would be put from a position of comparative security to one where they would have to exercise continual vigilance against a dangerous enemy. Suppose they duplicated their wires, they would have to watch and maintain them in a state of efficiency and responsibility that had never been put upon them, and unless that was done there would be the enemy ready to instantly pop in and make the signals wrong to the danger of the public. If both used insulated returns one might make a slip, but an accident to both would hardly occur at the same time. If traction companies worked with a complete return, and the railway companies took all precautions to prevent interference, in the case of accident in the working of the tramways the railways would be restored to a degree of safety. Until that was done he submitted that the railways would not be in a reasonable degree of safety. With regard to the use of a common return, or the earthing of a wire some distance away, he directed attention to the remarks of Mr. Spagnoletti on that point. The counsel then referred to the ownership by railways of gas and water pipes, and urged that by connecting the negative pole of the dynamo to the water-mains, corrosion would be set up between the latter and the gas-mains and injure all the railway structures. The railway companies asked that what was given at Bolton should be given as a regular protection. According to that, electric currents should be so constructed and tramways so worked as to prevent any injurious effects by leakage or induction in the wires of railway companies. Clauses to that effect were what the railway companies desired to be inserted.

Mr. Balfour Browne, on behalf of 12 large corporations, observed that they would be seriously affected by the legislation proposed on the other side. The corporations owned about £2,000,000 of tramways, and could purchase the other lines at the end of 21 years. About £15,000,000 in sovereigns had been spent on tramways, against £3,500,000, of which many were paper sovereigns, on telephony. Mr. Pember had mentioned the number of messages sent, but there were 500 000,000 passengers carried on the tramways. Tramway traction was far more important than telephony, and the town clerk of Walsall had stated that the Corporation would rather renounce telephony than traction. Not only had the telephone clause stood in the way of electric traction at Birmingham and Salford, but also at Glasgow, where the Corporation, not knowing the effect of the clause, asked and obtained electric powers in 1891. In the case of the latter no firm would undertake the responsibility of the clause. Mr. Sinclair had admitted that the system of working of the telephone company did debar an increase of traction. Was the committee, he asked, going to give such protection when millions wanted electric traction? Quoting from the decision given in the case of the Leeds tramway, he said that the decision by Mr. Kekewich was in favour of the tramway and against the telephone company. It was held distinctly that the Leeds company having got their tramway under a provisional order, had an absolute right to the use of the earth for the return current, even if that was injurious to the telephone company. That was the law, and the telephone and railway companies asked the committee to reverse it. If Mr. Sinclair was right, it was impossible with cheap traction by electricity for the telephone company to continue its present system. He claimed for the corporations an absolute right to use earth returns. If they had a provisional order, notwithstanding the telephones they ought to proceed. It was absolutely the case that the telephone company could make their system efficient by a metallic return, by the twisting of the wires to prevent induction. It was extraordinary that the telephone company should only do it where it was compelled, whilst the Post Office had adopted a complete metallic system. Mr. Forbes had said that in Liverpool and other towns it was likely that a metallic return should be adopted, and that that would be necessary also where traction was about to be adopted. Lord Kelvin had practically admitted that the double-wire system was necessary; he had said that the disturbances in London were partly due to the telegraphs and partly to the telephone wires themselves. Why did the telephone interests come and ask for protection against electric traction when they had to protect themselves against themselves and against telegraphy? Mr. Preece had said that he did not think a telephone circuit was complete or perfect until it was on a metallic circuit, and that ultimately the metallic system was cheaper. Mr. Swinburne and Mr. Crompton had stated that it was impossible to insulate tramways so as to make them really decently insulated. On the other hand, Sir Frederick Bramwell and Prof. Dewar had had no experience in that matter. Mr. Siemens, who had tried to introduce the Budapest system at Bradford, had said that there would be no difficulty of doing so in the outlying districts. The counsel stated that it was not in the latter, but in the towns where it was desired to adopt electric traction. Those three practical men—and there was no evidence on the other side except that it had been done at Budapest—said that it was impossible to insulate the return on tramways. The difficulty of induction according to Mr, Swinburne depended u the relative position of the conductors, and he had also said induction would take place through the most perfect insul more easily. Thus, even if leakage was to some extent prevented, induction would still take place, or the very thing that happened in Leeds. The telephone companies could protect themselves, but the electric traction interests could not, yet the former asked the committee to put that clause upon the latter to prevent electric traction ! Lord Kelvin had thought it possible that the traction companies might work with one insulated and a grounded return, and that the latter might arrange their apparatus so as not to interfere with the telephones. That was without an insulated metallic return, and that was being done at Blackpool without injury to the telephones. If that was so, and Lord Kelvin agreed, what other expense were the traction companies to be put to when a rearrangement of the wires would remedy the matter? Magnetic disturbances, as had been pointed out, were as injurious as traction, and were the traction interests to be put to serious expense for what was naturally done by earth currents? The Walsall disturbances had been overcome at trifling expense, and were the traction people to be put to the extra expense of £4,000 per mile? Mr. Langdon had said that, apart from electric traction, he would recommend the use of metallic returns ; whilst Mr. Spagnoletti asserted that so long as the insulation stood there would be no interference. As to electrolytic action, it was all nonsense, and until Mr. Preece's remarks, the gas and water companies were quite silent on the matter. Mr. Heskit and Mr. Crompton had not found any such action, whilst the Preston case had been disposed of by Major Cardew. Was there anything in it? There was not a word of truth in the assertion that an attempt was being made to introduce a bad system of electric traction. Mr. Justice Kekewich's decision was that the system was the best yet discovered. That was the system Mr. Moulton condemned. The corporations had not decided what system to adopt ; what they wanted was a free hand to introduce any system which was right and good. They did not want a clause that would give power, as did that of the telephone company. Mr. Pember had said it was a question of telephones against the whole electrical world. He (the counsel) said that the remedy was obvious. First, to get efficient telephones there must be a metallic circuit ; but he was not going to say that tramcars should be run without proper precautions. He thought Mr. Preece's suggestion fair and reasonable ; he had said that the remedy with telephones was to adopt metallic circuits ; with block signals it was equally simple, but with tramways it was different ; he said that the use of the earth by tramways should be subject to the supervision of the Board of Trade and the concurrence of the Postmaster-General. The counsel would protest against the adoption of insulated metallic returns to protect the telephones. If such a clause was passed it would stand in the way of all electric traction, and would be a serious detriment.

Mr. C. A. Cripps, in the interest of the electric traction companies, said that the latter had never used an earth return, and that they did not desire to do so. The question was as to the use of an insulated or an uninsulated metallic return. The clause the traction companies proposed was : "The company shall use metallic returns and in working their system shall take such reasonable precautions as the Board of Trade may direct for preventing interference with any properly-constructed insulated metallic circuit of any railway or telephone company and for preventing electrolytic action on gas or water pipes." The committee would observe that the basis of the clause was that the railway and telephones should use a properly-insulated metallic circuit, but if they did they were subject to the liability of the traction companies to use a metallic return ; the latter to be subject to the Board of Trade to work the lines so as not to interfere with the railway or telephone system, and also prevent any electrolytic action on gas and water pipes. All the scientific evidence pointed one way. As to electrolytic action, the traction companies did not believe in the difficulties that it was said would arise from electrolytic action, and they were willing to prevent it under the direction of the Board of Trade. The traction companies might affect telephones or railways, but they did not desire to do so, and they wished to be protected. The views of Mr. Preece had been confirmed by all witnesses irrespective of side, and his evidence had practically been put in the proposed clause. The traction companies only used the earth accidentally—that was, a certain amount of leakage went to earth. Mr. Preece had laid the greatest stress upon accidental returns and earth returns in the ordinary way ; he had not considered it necessary to absolutely insulate the railway returns ; but he thought that tramways could use the earth accidentally without disturbing the telephones. If the telephone people said that the traction system must be insulated, that was in the nature of protection ; but if a first-class system of telephony was desired, it was admitted that metallic returns must be used. The experience of Mr. Siemens's firm in all parts of the world could not be discarded, and that supported the contention that the metallic circuit system was the best. Lord Kelvin had admitted it, and nearly all witnesses agreed that in future a metallic service must be provided in all large towns. The best system was admitted to be an underground system, and to have that it was necessary to have a metallic system. There was a Treasury minute which stated that no further license would be given without the use of a metallic system. So far the Post Office, the Treasury minute, and the electrical interests agreed that a metallic service should be introduced, and that was the only way to get an efficient service. It had been urged that there would be a complete standstill if a change was made; yet in London, where there were no electric tramways, Mr. Gaine had said that the company were substituting the metallic system for the return. Of course that required time. The evidence of Mr. Bennett was uncontradicted : he said that a better and metallic return system could be erected practically as cheap as a single-wire exchange. There was not an authority greater than Mr. Bennett in the United Kingdom ; the latter would advocate a metallic circuit if a new system had to be devised, and he was a far greater authority than Mr. Gaine. That evidence had been corroborated by Mr. Crompton and others. The cost, too, was not appreciably more with a complete metallic circuit exchange, and was less by using a single return for a number of wires. Traction companies would interfere with the telephones without the latter used a metallic system. That had been shown at Leeds and in South Staffordshire ; at the latter the local authorities intervened between the parties. The traction companies would interfere with the telephones and telegraphs, and if that was to say that there was to be no development of traction in England without the adoption of the Budapest system, all the evidence concerning that line was that it could not be introduced in towns. The committee must either let the telephone companies go on destroying electric traction altogether, or if the latter was to have any development, a system must be introduced that would give fair protection to telephone companies and give electric traction a chance. As to railway signals, the traction people had said that they could not guarantee perfect insulation. Dr. Hopkinson had pointed out that unless the railway signalling apparatus was insulated, perfect safety could not be obtained. The railway companies must insulate their system, they must take the responsibility; and really that was apart from electric traction. Even if electric traction was stopped the railways must protect themselves, and according to the evidence no committee could sanction any electric system without the railways absolutely insulating their signal wires. If they did not they would not get the protection necessary for safety, and scientists agreed that they must do so. Coming to consider electrolysis, the counsel said that the difficulty could be met easily. Mr. Preece had said that alternating currents would not affect the pipes ; Mr. Swinburne had explained that by connecting the negative to the pipes all electrolytic action would cease. Major-General Webber, who had given special attention to the subject, agreed with them, and said that the matter could be treated with indifference. The traction companies agreed that it was a point that deserved careful attention, that it had been much exaggerated, that they would have no difficulty, and were quite willing to be under the direction of the Board of Trade in order to prevent electrolytic action, otherwise they would not have put that in the proposed clause. The traction companies only wanted their position to be fairly considered, and thought it would be obtained by some such clause as they proposed, and which appeared to be founded upon the evidence either by the traction or the telephone companies.

Mr. S. Pope, Q.C., in the interest of the gas and water companies, observed that in the clause proposed by the traction companies it only said "metallic returns," not continuously insulated returns. That clause might be paraphrased that "this committee recommends that traction interests should do as they are doing, and that the question of what restriction should be imposed upon them should be referred back to the Board of Trade." He thought it was an ingenious method of tempting the committee not to give any clause. He proposed to ask definitely that the committee should recommend that in all future grants of statutory powers to use electricity, insulated metallic returns should be required as a condition of the user. It seemed hard that a railway company should be compelled to spend money in protecting themselves, but the gas and water companies all over the country could not protect themselves against the danger of electrolytic action. In the opinion of one eminent scientist, that could only be effectually guarded against by the use of insulated returns. The question was a public question all round—whether in the interest of the general community any restriction should be put on electric traction so as to ensure public safety. Gas and water companies were not merely private enterprises. The leakage from uninsulated metallic circuits might create corrosion, additional risks of explosion, floods, etc., that were public inconveniences. A gas explosion was not merely the interest of the company ; it was a public risk and danger just exactly as was interference with railway signals. Absolute certainty could only be obtained by enacting that the return current should be entirely insulated, and they asked for that. The counsel did not attach the least importance to what had been found at Blackpool or elsewhere. There was no experience in this country on the matter, but in the United States one of the burning questions was that of electrolytic action. According to the paper handed in by Prof. Dewar, it was impossible to provide against it. The danger of corrosion to gas and water pipes could not be detected : it was a hidden source of danger that ought to be provided against ; it was, as Prof. Dewar had put it, an additional aid to the natural causes of corrosion, and he knew of no alternative than perfect insulation. Was the committee prepared to run the public risk that such a danger necessarily involved by the proposal of the clause before them? There was no reason why the risk should be run. It was urged that if traction was put under the same restriction as electric lighting, it would prevent its extension. But if the double-trolley system was not adopted, Sir Frederick Bramwell had said that it would be as easy to put two conductors in a conduit as one. The question for the committee was whether the risk ought to be run when it could be avoided. The gas and water companies' proposal, as a clause, was to the effect that an insulated return should be used, and nothing permitted to be connected to the earth.

Mr. Wallace, Q.C., said that if in the deliberations of the committee it was thought that anything should be done to affect the electric light companies, the latter, who had held aloof from the enquiry, should be permitted to appear before the committee.

In reply, the **Chairman** said that if that was done they would be informed.

This concluded the enquiry previous to the issue of the report of the committee.

COMPANIES' MEETINGS.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

The fourth ordinary meeting of this Company was held at Winchester House on Tuesday, Mr. George Herring in the chair.

After expressing great regret at the death of the former chairman of the Company, the late Duke of Marlborough, the **Chairman** proposed the adoption of the report. He stated that the authorised capital of the Company was £200,000, and the subscribed capital was £100,000, but the paid-up capital was only £20,000. That was why they had been enabled to make the dividend they recommended. They had invested the reserve fund belonging to the holders of the founders' shares in a manner which they believed would prove advantageous to that section of their proprietors; and the reserve fund of the ordinary shareholders was invested in the business of the Company. Their investments were taken at cost, but they had made an estimate, and they were convinced that they were worth the sum shown, even at the present depressed prices. In the three years since the Company was established the shareholders had received in dividends nearly 12s. 6d. on every sovereign they had paid to the Company, and the amount transferred to reserve fund represented another 10s. The mere fact that they were receiving a dividend of 25 per cent. for the past year showed that it was more or less speculative, and when a bad year came he hoped they would not reproach the Board. If there were prosperous years the public might feel inclined for electrical investments, and they had one which they would bring out.

Mr. J. B. Braithwaite, jun., seconded the motion, which was adopted, and the dividend recommended was approved.

BUSINESS NOTES.

Three-Wire Patents.—The Brighton Corporation have signed an agreement for the payment of royalties on the three-wire system.

Ealing.—The Ealing Local Board require tenders by July 5 for a central electric station. Particulars will be found in our advertisement columns.

Islington.—Applications for the post of electrical engineer to St. Mary's, Islington, must be sent to the vestry clerk, Upper-street, N., by July 5.

City of London Company.—Letters of allotment in the City of London Electric Lighting Company, Limited, issue of 20,000 preference shares have been posted.

Eastern Extension Company.—The Directors have declared an interim dividend for the quarter ending March 31 last of 2s. 6d. per share, tax free, payable on 15th prox.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,476.

St. Luke's.—At the last meeting of the St. Luke's Vestry, in reply to a question, the clerk said that a clause had been inserted in the agreement providing for accumulators sufficient to work the electric lighting scheme.

Foreign Elmores.—Shareholders who desire a full investigation into the affairs of Elmore's Foreign and Colonial Priority Company are invited to attend a meeting at Winchester House to-day, Friday, June 30, at 2 p.m.

Thomson-Houston.—Mr. Graff-Baker has left the Thomson-Houston Company to devote his time to the Electric and General Contract Company, of which he is managing director, and to undertake the financing and construction of electric traction lines.

London Electric Railways.—The Bill for the proposed electric railway from Waterloo to the City was referred on Tuesday to the Unopposed Bill Committee of the House of Lords. The City and South London Bill was also referred to the committee as unopposed.

City and South London Railway Company.—The receipts for the week ending June 25 were £765, against £747 for the same period last year, or an increase of £18. The total receipts for 1893 show an increase of £1,667 over those for the corresponding period of 1892.

Dundee.—The annual meeting of the Dundee Gas Commission was held last week. Mr. Jas. Mitchell, convener of the Finance Committee, stated, regarding the electric light, they had nothing to guide them yet as how it would result financially, but he moved that the present rate of 5d. per Board of Trade unit be continued.

North-Eastern Telephone Company, Limited.—This Company has been registered by Waterlow Bros. and Layton, Limited, Birchin-lane, E.C., with a capital of £1,000 in £1 shares. Object: To carry on the business of a telephone, telegraph, and electric light, heat, and power supply company. Table A mainly applies.

Belem (Brazil).—Tenders are required for lighting by gas or electricity the city of Belem, the capital of Gram Parà, Brazil, by contract. The conditions of contract and all particulars may be had on application to the Brazilian Consulate, 6, Great Winchester-street, London, E.C., or at the Consulates of Liverpool and Glasgow.

Bolton.—The sub-committee of the Gas Committee, who have in hand the question of electric lighting in Bolton, held another meeting last week, when certain details in regard to the undertaking were considered and advanced a stage. It is expected that by the next Council meeting the information on the subject in regard to the committee's proposals will be complete.

Heriot's Hospital School.—The governors of the George Heriot's Trust have decided to erect a new examination hall for the Heriot's Hospital School. The building will be heated and ventilated by steam, and lighted by electricity from the present technical department of the school. The design is by Mr. Donald A. Gow, architect and superintendent of works to the Trust, and the building is to be ready for use by the end of the session 1893-94. The cost will be between £8,000 and £9,000.

West African Telegraph Company.—The revenue for the year amounted to £60,922. 14s. 2d., against which £20,018. 14s. 8d. is charged for ordinary expenses, £13,964. 3s. 7d. for expenditure relating to repairs of cables, etc., and £802. 10s. 3d. for income tax, leaving a balance of £26,137. 5s. 8d. From this amount is deducted £23,726. 15s. 10d. (being for interest on debentures £13,060. 2s 6d., and for sinking fund £10 666. 13s. 4d.), leaving a balance of £2,410. 9s. 10d., which it has been decided to carry forward.

Paddington.—The reception of the accounts of the Metropolitan Electric Supply Company, Limited, formed a subject of discussion at the Paddington Vestry as to the wisdom of the Vestry in declining to carry out the supply of electric light. It appears that after two years' work the company had made a profit of 2 per cent. Colonel Barchard congratulated the Vestry in declining to embark on the enterprise, as some members desired to do. The result was that the Vestry had got its money and the company the electric light. At present the company had only 297 customers in Paddington.

United River Plate Telephone Company.—The report for the year ending March 31 states that after deduction of expenses in the River Plate, loss on exchange, debenture interest, and other London charges, the Directors state that the year's working has enabled them to write off £768, the balance of taxes suspense account, £2,728 for bad and doubtful debts, and to carry £3,000 to depreciation and renewal fund. There then remains a balance of £540, increased by £365 brought forward from the previous year to £905. Since March 31 last the business of the Company has kept pace with the general improvement in affairs in the Argentine Republic.

Metropolitan Asylums.—The Small-pox Hospitals Committee of the Metropolitan Asylums Board last Saturday reported recommending that, subject to the approval of the Local Government Board, the estimate of Messrs. Latimer Clark, Muirhead, and Co., of 23, Regency-street, Westminster, S.W., for the supply and erection of a telephone system at the Gore Farm Hospital, in accordance with a specification prepared by Dr. J. Hopkinson, be accepted at the sum of £270. This was agreed to. The following is a list of the estimates received from the other selected firms: Consolidated Telephone, etc., Company, Farringdon-road, £328. 13s.; Messrs. Spagnoletti and Crookes, Goldhawk-road, £400.

Harrogate.—The projected floating of a private company for the supply of electric light for Harrogate has been abandoned. It was at first thought that a local company could be got together, and with this view meetings of the promoters were called to take the initiative in the matter, but from the report of the consulting electrical engineer, the scheme would require an extensive floating capital. This fact was laid before a recent meeting of private supporters, and it was deemed that the company could not be floated. It now devolves upon the Corporation of Harrogate to take action in the matter, and thereby prevent any other company coming in. The question of electric lighting has already been freely discussed in the Council.

Barnet.—A parliamentary paper has been published stating in reference to the electric lighting provisional order, for which the Barnet Local Board has applied, in order to keep out outsiders, that Lord Playfair has given notice of the following amendment to be moved on the third reading of the Bill, dealing with this and similar orders: "Barnet Order, page 55, line 7, after ('any') insert ('such'). After line nine insert the following subjection: '(5) Provided always that if the undertakers or any such owner at any future time apply to Parliament to appeal or amend the foregoing provisions in accordance with the report of a joint committee of both Houses of Parliament (whether such report shall or shall not be retrospective in its recommendations), such owner or undertakers, as the case may be, shall not be entitled to oppose such application except on details.'"

Launceston (Tasmania)—Tenders for supply and erection of electric lighting plant are invited for the city of Launceston, Tasmania. Sealed tenders, addressed to Mr. C. W. Rocher, town clerk, Launceston, Tasmania, will be received at his office up to 12 o'clock noon on Saturday, December 30 next, for the execution of the following works at and near Launceston—viz.: 1. The supply and erection of turbines, arc dynamos, alternators, etc., and all necessary fittings at the generating station. 2. The supply and erection of poles, fittings, insulators, leads, clips, etc. 3. The supply and erection of arc and incandescent lamps, holde reflectors, meters, etc. 4. The supply for carbons for arc lamps and spare leads. 5. Maintenance and working of installation for six consecutive months. Plans and specifications may be seen at the office, where also all particulars may be obtained.

Lambeth.—The Workhouse and Infirmary Committee of the Lambeth Guardians have recommended, and the Board have agreed to obtain, the opinion of Mr. Preece, or some person nominated by him, as to the practicability, cost, and ultimate economy of lighting the Renfrew-road workhouse and infirmary by electricity. The master of the Hackney Workhouse had, it was stated, readily supplied the committee with information as to the advantages of the use of electricity in that institution, where the light was a complete success. Before the matter was discussed, the Chairman, addressing the chairman of the committee, said: "You won't be mad enough to propose this expenditure at the present state of electric lighting." Mr. Mann, the chairman of the committee, said they were only anxious to ascertain the expense and expert's advice, for the whole of Lambeth only cost the Vestry £50. The chairman said the extra boiler accommodation would cost £5,000. The limit of the cost of expert's opinion is to be £30.

Electrical Trades Union.—The head office of the Electrical Trades Union is now 59 and 60, Chancery-lane, W.C.; secretary, Mr. A. J. Walker. The union has 30 branches and 1,700 members. A new branch has lately been opened at Birmingham, and branches will be opened in Portsmouth, Devonport, Dublin, Dundee, Edinburgh, Aberdeen, Chelmsford. There are numerous benefits for the contribution of 6d. per week. The following are eligible who are competent in one or more of the following branches: Armature, magnet, and transformer winders; erectors and tenders; installation linesmen and wiremen, indoors and out; battery accumulator makers, fitters, and inspectors; telegraph and telephone wiremen and linesmen faultfinders; instrument makers; installation attendants, land or sea; electrical traction employés; also assistants who have been employed for 12 months and upwards, whether telegraph, telephone, or electric light construction and maintenance. The central office is open till 5.30 p.m., or later by appointment.

York.—At last week's meeting the Electric Lighting Sub-Committee of the York Corporation had under consideration, in conjunction with Prof. Kennedy, their electrical adviser, the several tenders for the lighting of the city by electricity. With the exception of a tender from Messrs. Crompton, the whole of the tenders were from companies adopting the high-tension system. After consultation the sub-committee came to the conclusion that the high-tension system would benefit the city in the future in a more efficient degree than the low-tension scheme, and it was subsequently resolved to place that opinion before the full committee, together with the recommendation of one of the tenders for acceptance. On the meeting of the full committee it was generally felt that, before so important a question as the adoption of a system should be decided, it would be advisable to be in possession of a digest of the present electrical adviser's reports, and the meeting was eventually adjourned so that the whole of the members could be placed, as far as possible, in possession of the main features of the two systems. It is anticipated that the citizens will shortly have information of a definite character before them.

St. Saviour's, London.—At the meeting of the Board of Works last week the Paving and General Purposes Committee reported that they had received a letter from the secretary of the City of London Electric Lighting Company, Limited, stating that the company have purchased the freehold of the whole of Pitt's-place, and of the west side of William's-court, and that they proposed to build a generating station on the site thereof, and of the cottages to be pulled down; also a notice from the solicitors of the company stating that the company desire to stop up Pitt's-place, and asking for the consent of the Board to their doing so, preliminary to an application being made to the justices for closing it as a highway. Having carefully considered the application and heard a statement by Mr. Cook, the engineer and manager of the company, the committee were of opinion that the application should be acceded to, and recommended that the Board's consent should be given, subject to the company making, at their own expense, the necessary application to the justices, and undertaking to provide as much accommodation for the working classes to be displaced as will correspond with the number of houses to be pulled down, and that the buildings to be erected for their accommodation shall not exceed three floors in height. The report of the committee was adopted.

Newport.—At a special meeting of the Newport City Council, the sub-committee of the Parliamentary Committee on electric lighting reported in favour of the adoption of the high-tension alternating-current transformer system as being generally the most suitable for large and straggling districts. They also recommended the appointment of an electrical engineer in order to prepare plans, specifications, and estimates. The installation should be capable of supplying the current in the first instance to the whole of the borough on the western side of the river, but the central station in Friar's Field should be so planned that the necessary space would be provided for the machinery required to extend the supply to the eastern district. This report was adopted, but Alderman Bear asked how far it was committing the Corporation. Did the report pledge the Corporation to any particular expenditure? The Town Clerk said the question of cost and of providing the money would again come before the Corporation, as they would have to apply to the Local Government Board for leave to raise a loan. The Corporation, however, had on a previous occasion committed itself to electric lighting. Alderman Vaughan asked if it would not be better to adopt the course taken at Oxford and Leeds—viz., allow a company to set up their own undertaking—and then, when they had made a success of the scheme, purchase it from the company at 5 per cent. The Mayor said the sub-committee had, he believed, not been shaken in their view that the electric lighting should be undertaken by the Corporation.

Board of Trade.—The following notice has been issued: "Whereas, in certain regulations made by the Board of Trade under the Electric Lighting Acts, 1882 to 1890, and certain provisional orders and licenses granted under those Acts, it is provided that where the supply of energy is transformed at a converting station some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure distributing mains shall be at any time charged to a dangerous difference of potential from the earth owing to any accidental contact with, or leakage from, the high-pressure system either within or without the converting station; and, whereas in such regulations it is also provided that where any transforming apparatus is installed on a consumer's premises some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure service lines and consumer's wires shall be at any time charged to a dangerous difference of potential from the earth owing to any accidental contact with, or leakage from, the high-pressure system either within or without the transformer; now, therefore, the Board of Trade approve of the apparatus known as the Cardew earthing device of the pattern deposited at the Board of Trade laboratory, sealed, and numbered 3, 3A, and 3B, for use under such regulations: provided that in all cases in which such devices are used suitable quick-acting fuses or cut-outs are inserted in the high-pressure circuit, and that in any case where the high-pressure current to the transforming apparatus may exceed 30 amperes, two such devices at the least shall be used."

New Swindon G.W.R. Mechanics' Institution.—A well-attended meeting of the Junior Engineering Society, in connection with the recent visit to Bath, was held in the lecture hall of the institution on Wednesday, June 21, Mr. A. E. Leader in the chair. Very interesting papers were read by Messrs. W. L. Holt and H. G. Cotsworth respectively, descriptive of the works of Messrs. Stothert and Pitt, and of the Bath Electric Lighting Works. Mr. Holt dealt with the nature of work in hand in the different shops, remarking on the predominance of crane work. He then proceeded to describe the principal objects of interest, chief among which was a 25-ton Titan for block-setting at Pernambuco, which had recently been tested; two traversing cranes for Southampton and Dover, and several of the firm's standard two and three ton cranes in various stages of construction. Mr. Holt concluded with a reference to some photographs of cranes made by Messrs. Stothert and Pitt. Mr. H. G. Cotsworth's paper opened with a brief history of Mr. Massingham's pioneer work in municipal electric lighting in the West of England, of which the installation at Bath is one of the most successful results. With the aid of some admirable sketches he then explained the general principles of the Thomson-Houston dynamo, which type is used in this installation, together with the very ingenious arrangement for regulating the potential of the current supplied. Also in the same way Mr. Cotsworth very clearly explained the method of preventing excessive sparking by means of a neat air-pump fixed to the dynamo shaft. With a description of the engines and boilers, and also of the system of laying the cables, Mr. Cotsworth concluded his excellent paper. Messrs. Tincknell, Stephens, Dominy, and Leader took part in the discussion which followed, and with a hearty vote of thanks to Messrs. Holt and Cotsworth, and also to Messrs. Stothert and Pitt, Mr. Massingham and his chief engineer, Mr. Metzger, the proceedings terminated.

Blackpool and Lytham Electric Tramway.—The Blackpool, St. Anne's, and Lytham Tramways Bill came before the Committee of the House of Commons on Unopposed Bills last Friday, as an unopposed measure. By the Bill it is sought to obtain powers to construct a tramway from Blackpool to Lytham, an improvement which it was stated was greatly needed in the neighbourhood. It is proposed that the tramway shall be eight miles in length, and that the company to come into existence under the Bill shall be empowered to connect their tramways with those already within the area of the Blackpool Corporation, and the Corporation are to be empowered to grant a lease of their lines to the company. Mr. Tahoudin said that the Bill was designed to meet a great want. At present all the passengers between Blackpool and Lytham were conveyed by train. Power was inserted in the Bill to work it either by electricity or animal power. The portion of the tramway inside the borough of Blackpool would still belong to the Corporation, but the portion outside would belong to the company. The portion inside the borough was to be leased to the company. The lease would be for 24 years. They had reduced the fares to be charged on these tramways. One of the new clauses dealt with the negotiations with the Corporation of Blackpool. To that clause, of course, the agreement which had been entered into with that body would have to be scheduled. They had now come to a final agreement with the Corporation, and the lease had now been issued and would be scheduled to the Act. Clauses would be inserted for the protection of the National Telephone Company, which had been agreed to by that company. Clauses would also be drawn up for the protection of certain of the estate owners whose estates abutted on the proposed tramways. Mr. Chandos Leigh said there was one other clause with reference to the company using other means of conveyance besides tramways, which he thought should be inserted in the Bill as a separate clause. Mr. Tahoudin said that that clause should be adopted. The clause would empower the company to acquire by hire or by purchase, in connection with their tramways, omnibuses and other vehicles. There was no power in the Bill to use steam on these tramways. The Bill has been read for the third time in the House of Commons.

Cardiff Tenders.--A special meeting of the Lighting and Electrical Committee of Cardiff Corporation was held in the Council-chamber on Monday, under the chairmanship of the Mayor (Councillor Vaughan), there being also present Aldermen Jacobs and Carey, Councillors J. Munn, W. J. Trounce, J. Jenkins, and F. L. Short, the borough engineer (Mr. W. Harpur), and the consulting electrical engineer (Mr. Massey). Tenders for the supply of boilers, machinery, and electrical apparatus were received and considered, there being 26 in all. The consulting engineer stated that in his opinion they could get all the machinery, etc., required, for about £10,600 if the different portions of material were supplied by different firms. Alderman Carey thought there should be no divided responsibility, and that the laying down of plant and machinery be given to some firm whom they could trust. There were eight tenders for the whole of the machinery and plant—namely :

Ferranti and Co., London	£12,700
Brush Engineering Company	12,200
Latimer Clark, Muirhead, and Co.	11,500
Crompton and Co.	11,200
Johnson and Phillips	11,000
Siemens Bros.	10,900
Woodhouse and Rawson	10,800
John Fowler and Co. (without boilers), over	11,600

There were 18 other tenders for portions only, or for types of machinery and apparatus, not in accordance with specifications. After deliberation, the committee decided to accept the following tenders : Boilers, Messrs. Davey, Paxman, and Co., Colchester ; condenser, Messrs. James Watt and Co., Birmingham ; engines, dynamos, switchboard, transformers, rectifiers, etc., Messrs. Siemens Bros., Limited, London ; lamps and special automatic cut-outs, Messrs. Johnson and Phillips, of Charlton. The selection of lampposts and other small things have been deferred. The total amount of the tenders accepted is £10,200.

Royal Hotel, Blackfriars.—Sir Polydore de Keyser's palatial Royal Hotel at Blackfriars, London, has been fitted throughout with electric light by Messrs. Siemens Bros., the cost in all being a sum of over £14,000, so that it can be seen a very fair-sized central station is required for this hotel alone. The total length of cable and wire amounts to over 44 miles. The Royal is now one of the most perfectly equipped hotels in London, not to say the whole of Europe. An entirely new block of buildings has been erected at the back for the machinery, and the whole plant, to avoid risk, has been duplicated. There are three Willans engines driving Siemens dynamos. The engines are of 80 b.h.p. at 450 revolutions, and the dynamos give 440 amperes at 115 volts. Any two of the sets is more than sufficient to supply the whole light. Steam is supplied by three Babcock and Wilcox boilers, two of which are in constant use. The feed-water is obtained from an artesian well sunk in 1876. A fine switchboard controls the supply in all parts of the hotel, and space is left behind for convenience of connections. All main cables are armour-plated. On entering the courtyard the visitor sees 31 large incandescent lamps tastefully arranged round the hotel amid flowers and shrubs in true continental style. On entering the hall immediately inside the hotel, the first thing to meet the eye is the arrangement of coloured lamps extending from the first to the fourth floor. The dining-rooms, which have lately been beautifully redecorated, are lighted with large lamps that throw a pleasant glow on the tables. The smoking and reading rooms, which look on to the Embankment, are lighted by incandescent lamps, and present to view a picture that is unique in London. In addition to the lamps that hang from the ceiling there is on each table a small lamp, which can be lighted at the will of the visitor. Electric cigar lighters are also fitted. The system adopted as regards the lavatories throughout the hotel, allows the opening of the door to switch the light on, while when one leaves and closes the door an automatic arrangement comes into play and cuts the current off. In the bedrooms, on opening the door the visitor finds close to his hand a small switch, the pressing of which switches the light on, and a similar switch is placed immediately over the bed, so that when the visitor has retired, and wishes to turn the current off, all he has to do is to press the button. The attractiveness of this well-known hotel is now certainly completed by the very elaborate installation of electric light.

Maidstone.—The Electric Lighting Committee presented the following report : In accordance with your instructions your committee advertised for information as to the terms on which a company or firm would undertake and carry out the powers granted to your Authority under the Maidstone Electric Lighting Order, 1892, special regard being had to the system of lighting, the maximum charges to consumers, and the time for which a contract should run, or a deed of transfer extend. Five replies to the advertisement have been received and carefully considered by your committee, who are of opinion that the terms offered by Messrs. Sharp and Kent, and Messrs. Bourne and Grant, for taking over and carrying out the order are the most likely to meet the views of your Authority. Messrs. Sharp and Kent are prepared to take over and work the provisional order on the following terms : 1. That your Authority and the Corporation give the firm the whole of the public lighting, guaranteeing a minimum sum per annum of £500. 2. That the Board of Trade be petitioned for an extension of time within which the conditions of the order are to be fulfilled. 3. That your Authority have the right to purchase the undertaking at the end of 10 years on paying for the plant and a goodwill of five times the previous year's net profit, or at an earlier period if desired by your Authority, subject to special arrangements being made. 4. That your Authority find a suitable site for the works, in a position to be approved by the firm, who shall pay a rental for the same. 5. That the maximum charge shall be 8d. per unit. 6. That the question of "system" be left entirely in the hands of the firm, who are greatly in favour of Andrews's concentric system. 7. Arrangements can be made for the repayment of the cost of the provisional order out of profits earned. 8. A discount of 25 per cent. will be allowed for public lighting from the maximum rate charged, provided a minimum annual payment is guaranteed by the local authority. Messrs. Bourne and Grant are prepared to take over the powers, rights, duties, and liabilities under the order by way of absolute transfer (with the assent of the Board of Trade) on the following terms : 1. To repay the costs of the order and those incident to transferring the same (if carried out), not exceeding £500. 2. The firm will carry out the terms of the order, and agree with your Authority as to the minimum number of lights which should be at first provided for, and provide sufficient plants, mains, etc., to meet all demands that may from time to time be made for supply within the area covered by the order. 3. The firm will, before proceeding with the work, make complete surveys and submit a scheme for the approval of your Authority, as far as practicable adopting any suggestions of your Authority as to the method of lighting (providing the same are approved by the Board of Trade). 4. Your Authority to have the option of purchasing the undertaking at the end of 21 years from date of transfer at a valuation to be based on the fair market value of the undertaking as a going concern. Six months' notice of such intention to purchase to be given by your Authority. Such option to purchase on same terms may recur at every fifth year after the twenty-first up to the forty-first year from the date of transfer—at the end of the forty-first year from date of transfer—the purchase may be made as prescribed by Sec. 2 of the Electric Lighting Act, 1888. 5. The firm would agree to frame a scale securing consumers certain rebates from the authorised maximum charge, such rebates to be proportional to the quantity of energy used, and would further agree to supply electrical energy for public lighting at a discount of 20 per cent. from the maximum rate charged to consumers. Messrs. Bourne and Grant are prepared, if preferred by your Authority, to enter into a "contract" instead of taking an absolute transfer of the order, on the following terms : To provide necessary money and carry on, on behalf of your Authority, the duties and liabilities under the order, subject to a site being provided for an electrical station, a guarantee given for a minimum number of lamps, and your Authority agreeing to purchase the undertaking in 21 years at a valuation based on the fair market value of the same as a going concern. Messrs. Bourne and Grant are now preparing a draft scheme and contract.—The Mayor said they all had the report of the Electric Lighting Committee before them ; he did not know whether any member would like to move a resolution on the subject. Mr. Baker said he would like to move that the whole matter be referred back to the committee for further consideration. He thought it was known that all the members of the Board had had forwarded to them a scheme which was before the committee, but no mention of it was made in the report. The scheme was from a local tradesman, and he thought it should have the consideration of the committee. (The Mayor : It has.) Mr. Baker, continuing, said he did not want to go into the merits of the matter, but it seemed to those not on the committee that there were certain advantages in that scheme which did not appear in the others. He had the greatest confidence in the present committee, but the matter was so important that he thought the question should be considered by a committee of the whole Board. They wanted to go into the details again. The Mayor said Mr. Baker's remarks tended to refer the matter to the Board in committee. Mr. Baker said then if he was in order he should like to move that. Mr. Tootell seconded. In answer to Mr. Cox, the Mayor said the Board had not given up the idea of keeping their provisional order in their own hands. The resolution was then put and carried.

Manchester Telephone Wires.—At the Manchester City Council last week, Mr. Alderman Milling moved the adoption of a report of the Paving, Sewering, and Highways Committee in relation to telephones, together with the following resolution : "That the Paving, Sewering, and Highways Committee be instructed to communicate with the National Telephone Company or any other company that may desire to approach them, also to present a special report to the Council as to the terms and conditions upon which it is proposed to carry the arrangement into effect, but that until such a report has been considered and sanctioned by the Council no engagements whatever be entered into on the part of the Corporation." He said it would be seen from the report which had been presented to the members of the Council that the town clerk had been in communication with the secretary of the National Telephone Company, who had a project in view for an extensive rearrangement of their wires with a view to extending and facilitating their business. They proposed to place in certain streets pipes of 3in. bore, each of which should accommodate 100 subscribers' wires. The matter was a very important one, and the committee desired some expression of opinion on the part of the Council as to what course they should pursue in reference to the proposal. Mr. Alderman Reade seconded, and Mr. Tetlow supported the resolution. Mr. Southern moved as an amendment :- "That the Paving, Sewering, and Highways Committee be instructed to refuse the privilege to any company of laying under the publi channels, culverts, or any other property thoroughfares. That the committee be requested further to c sider the public advantage of laying telephone wires underground, and if satisfied of the advantage to report to the Council the probable cost of the necessary provision, and the best modes of obtaining competition for the use thereof; and further to report upon the expediency in either letting or leasing the said provision of limiting the charge to subscribers or users." He said he did not think the Council had any sufficient reason in the request before them for departing from a sound principle which they had deliberately adopted in a number of other cases. He had no doubt that the placing of these wires underground would be a considerable public advantage, for they were an eyesore to the streets, and as they became more numerous they became more and more objectionable. Beyond that, the telephonic system was comparatively new. The wires were of a nature to corrode in the course of a few years, and considerable danger might arise from them. Already there was inconvenience caused by them in winter during storms, so that he had no objection, but rather the contrary, to the proposition that it would be better that the wires should be placed underground. The privilege, however, was an exceedingly valuable one, and before it was conceded they must know what the terms were going to be. They should not only know what the Corporation were going to receive, but what was to be charged to the citizens for the use of the wires. Before they let a privilege like that to one particular company they must insist that the citizens should have the use of the wires at something like a reasonable rate. In some continental cities, and in America, charges were made in accordance with this principle. He had heard it suggested that he had some interest in the matter. He had only to say in regard to that that he had been for 25 years in public life, and he had never preferred his private interest to the public interest, and never intended to do. As far as his interest went it was on the other side, and not that on which his contention had been. It was a small interest, but such as it was it would suffer by the course he recommended the Council to adopt. He desired, before a decision was come to, that the Government Post Office Department should be invited to tender for this underground privilege. It had its telephonic exchanges in other towns, and they were successful, efficient, and satisfactory. He wanted that the people of Manchester should be put in as good a position as the people of other towns. Mr. Locke seconded the amendment. Mr. Alderman Joseph Thompson said he was in an unpleasant position, because he was officially connected with the National Telephone Company. That company appeared before the Corporation, and it had appeared before the Corporation for seven months without an answer, asking simply to be allowed to do, either by itself or at the hands of the Corporation, what they wished to compel it to do some years ago. At that time it was a small provincial company and would have been unable to do it, because to be compelled to lay the wires underground would have been to crush it out. The House of Commons intervened, and the matter was allowed to stand over, and from that day to the present nothing had been done by the Corporation of Manchester with respect to governing the telephones. Now things were altogether different. The use of telephones had largely increased, and they had become an actual necessity. The overhead wires had become an eyesore and a great expense, and the company asked to be allowed to do that which the Corporation would have forced them to do some years ago. The company would either do the work themselves or let the Corporation do it, and they would rather that the latter course was adopted. They did not desire to put their pipes in front streets. He asked the Council not to cripple a company that was trying to do its work well, but to give it reasonable facilities. He did not think, with reference to the Post Office, that it would enter into this business. It already did its telegraphic business at a loss. After a brief discussion, the motion and amendment were withdrawn in favour of an amendment of the resolution to the effect that the committee be authorised to negotiate with any telephone company or private owners or the Post Office Department of the Government on the subject of underground telephone wires, but that before any arrangements were carried into effect the committee should present a special report.

PROVISIONAL PATENTS, 1893.

JUNE 19.

12006. **Strong's arc lamp shade.** Jonathan Strong, The Weavers' Arms Distillery, Newington Green-road, London.

12011. **Electric low-water alarm for steam-boilers.** Richard Brown, 43, Milner-street, Preston.

12032. **Improvements in electric travelling cranes or hoists.** Easton and Anderson, Limited, and Edward William Anderson, 47, Lincoln's-inn-fields, London.

JUNE 20.

12070. **Improvements in switches for controlling electric currents.** Charles Richardson and Edward G. Herbert, Cornbrook Park-road, Manchester.

12139. **Improvements in electric machines and transformers.** Maurice Hutin and Maurice Leblanc, 28, Southampton-buildings, Chancery-lane, London.

12141. **Improvements in electrical time switches for signalling.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

12142. **A safety switch for electrical lock and block apparatus on railways.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

12143. **Electrical apparatus worked by passage of a railway train or vehicle.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

12153. **Improvements relating to methods of measuring, controlling, and regulating electric currents, and to apparatus therefor.** Addison Goodyear Waterhouse, 45, Southampton-buildings, Chancery-lane, London.

JUNE 21.

12191. **An improved globe or shade holder for electric, gas, or other lamps.** William Howard Ingall, Triangle-chambers, Martineau-street, Birmingham.

12196. **Improvements in the arrangement of telephone circuits and switching devices therefor.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

12233. **Improvements in controlling, adjusting, and mounting movable coils in telegraph recording instruments.** John Gott, 55, Bishopsgate-street Within, London. (Charles Cuttriss, United States.)

12242. **An improved electrical lighting device.** Jules Emile Sénéchal, 45, Southampton-buildings, Chancery-lane, London.

JUNE 22.

12249. **Certain improvements in electrical switches.** Arthur David Ash, Wood-street, Willenhall, Staffordshire.

12257. **Improvements in electricity meters.** Gustav Binswanger and Herbert John Coates, 71, Queen Victoria-street, London.

12291. **Improvements in secondary batteries.** Alfred Julius Boult, 323, High Holborn, London. (Henry Woodward, Canada.) (Complete specification.)

12314. **Improvements in electrically-illuminated signs.** Guy Carey Fricker, 15, Spencer-road, Putney, London.

JUNE 23.

12362. **Apparatus for the marking of meat by electricity and other analogous purposes.** Montagu Fullerton Armstrong, Joseph Kincaid, John Edward Waller, and Edward Manville, 29, Great George-street, Westminster, London.

12374. **Improvements in portable electric lamps and batteries therefor.** Henry Charles Gover, 28, Southampton-buildings, Chancery-lane, London.

JUNE 24.

12437. **A mode of and means for electrically controlling lubricators.** Percy Rosling and Frederick Joseph Arundel Matthews, 9, Old Bank-chambers, Park-row, Leeds.

12444. **Improvements relating to electric railway signals.** Jefferson Bradford and James Polk Williams, 55, Chancery-lane, London.

12457. **Improvements in junction-boxes for underground electrical conductors.** David Urquhart and James Milne Small, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12458. **Improvements in alternating-current electric machines.** Maurice Hutin and Maurice Leblanc, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

1094. **Electric lamps.** Johnson. (Second edition.)

10696 **Cover for electric push knobs, etc.** Shiels.

11624. **Coin-operated telephone.** Lake. (Noriega.)

11634 **Electric railways.** Wynne.

12311. **Electric alarms.** Darrah and Gough.

12528. **Telephonic apparatus, etc.** Anders and Kottgen.

12737. **Electrical switches.** Jenner and Wilkes.

13473. **Heating and cooking by electricity.** Binswanger.

1893.

4923. **Electric lamps.** New.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2½
City of London	—	11⅝
— Pref.	—	12⅝
Electric Construction	10	4
Gatti's	—	5¼
House-to-House	5	5⅜
India Rubber, Gutta Percha & Telegraph Co.	10	23
Liverpool Electric Supply	5	6¼
	3	4½
London Electric Supply	5	1
Metropolitan Electric Supply	—	6¾
National Telephone	5	5½
St. James'	—	8¼
Swan United	3¾	3⅛
Westminster Electric	—	5¾

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